MARCH 14, 1955

22nd Annual "Inventory of Airpower"

AVIATION WEEK

A McGRAW-HILL PUBLICATION

Airpower in the age of peril

THIS ISSUE $1.00

His Throttle Feeds 100 Questions-per-Minute to the Holley Turbine Control

Providing automatic solution to fuel metering problems is the job of the Holley turbine control for many of today's jet engines. Hundreds of math problems per minute result from minor changes in altitude, temperature and humidity, plus the pilot's demand for different speeds.

Holley's research and engineering division played an important role in the development of the turbine control. Manufacturing it, too, called for many special skills and techniques.

The Holley manufacturing division produces turbine controls for all types of jet engines. Special manufacturing skills are required for such close tolerances as 2 micro inch finishes on valves and bearing surfaces.

Holley's highly-trained research, engineering and manufacturing staff can support your program of producing better products for the aviation industry.

LEADER IN THE DESIGN, DEVELOPMENT, AND MANUFACTURE OF AVIATION FUEL METERING DEVICES.
VAN DYKE, MICHIGAN

HOLLEY Carburetor Co.

A-20

You asked for it...

HERE IT IS!...

MEMO TO: Aircraft Designers

Another step towards design simplification is made possible by the introduction of the new Fafnir B500DD series bearings. Through the first successful application of shields to an extremely thin section, torque-tube type bearing, housings can be simplified...space and weight reduced.

The B500DD is equipped with non-metallic, close-clearance shields positively attached to the outer ring by a special method...no further sealing needed except in extreme cases. All exposed surfaces are cadmium plated. Full faces are provided on both inner and outer rings. The B500DD has a full complement of balls and is pre-packed with the precise amount of lubricant for satisfactory service without relubrication. It is available in a full range of bore sizes from .6250 to 2.3125 with a constant inner ring width of .281 and outer ring width of .250.

A new bulletin containing complete specifications and engineering data is available. Send for a copy and investigate the advantages of this new development. The Fafnir Bearing Company, New Britain, Conn.

THE FAFNIR B500DD THIN SECTION TORQUE-TUBE TYPE BALL BEARING

TYPICAL DIMENSIONS: BEARING NO. B500DD

Bore: 1.3125
O.D.: 1.7500
Inner Ring Width: .281
Outer Ring Width: .250
O.D. Inner Ring: 1.451
Inner Ring Corner Radius: .015
Outer Ring Corner Radius: .015
Balls, Number: 38
Balls, Size: ⅛"
Weight, Pounds: .09

FAFNIR
AIRCRAFT BEARINGS

FIRST...at the turning points in aircraft design

AVIATION WEEK

March 14, 1955
Volume 62 Number 11

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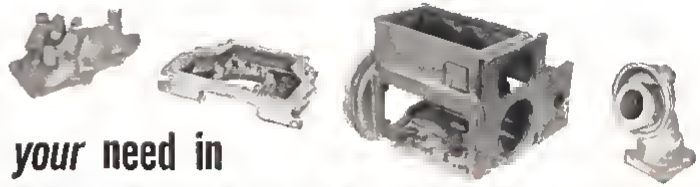
North American's FJ-4, latest of the Fury series of Navy jets, flies with vital parts made of titanium—from nose to tail. For this fastest of the Furies has a heritage of titanium.

It was because of titanium's high strength-weight ratio . . . its corrosion resistance in sea air . . . its freedom from stress-corrosion cracking that titanium was specified for the FJ-2 and the FJ-3. It was the production experience and the performance of REM-CRU titanium alloy parts under the rugged conditions of supersonic flight that led to the further use of REM-CRU C-110M and C-130AM for primary fuselage frames and stiffeners, webs, angles and wing spar fitting on the FJ-4.

REM-CRU, pioneer in titanium alloys for aircraft applications, has expanded production facilities for sheet, strip, plate, bar, wire and tubing. This means your selection of size, shape and alloy grade can be delivered on schedule for your requirements. And REM-CRU engineers are always ready to assist with the application and fabrication of titanium.

To keep abreast of the latest developments on this vital metal, write to Dept. 4W3 for the Rem-Cru Review—a free periodical presenting the latest technical data on titanium alloys.

REM-CRU TITANIUM REM-CRU TITANIUM, INC., MIDLAND, PENNSYLVANIA



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Check-Chart Shows Versatility of Bendix Foundries

PROCESS USED	METAL WORKED	
	ALUMINUM	MAGNESIUM
Sand	✓	✓
Plaster	✓	✓
Shell Mold	✓	✓
Die	✓	✓
Permanent Mold	✓	✓

FREE . . . "Book of Facts"!

Please send me your "Book of Facts" on magnesium and aluminum castings

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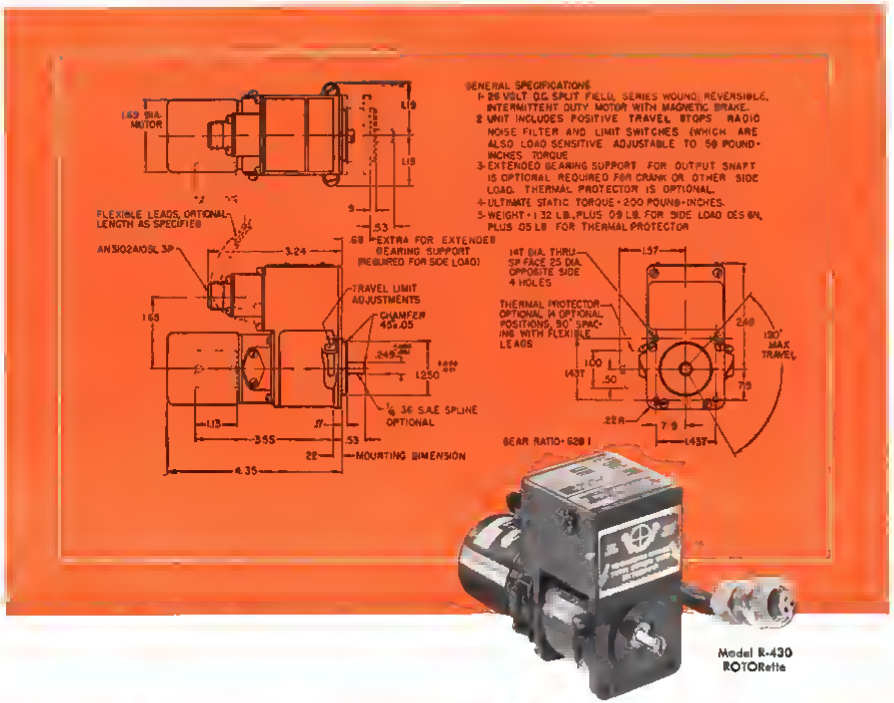
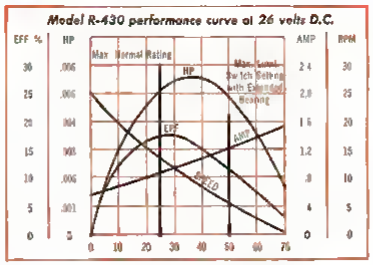


Model R-430
ROTORette

THE ACTUATOR THAT KNOWS WHEN TO STOP

Once the original limits are set, this compact rotary actuator actually "senses" the additional load imposed by running against the adjustable stops, and halts automatically. This load-sensing feature, plus the positive stops, eliminates over-travel completely. These features have attracted the attention of such leaders as Grumman, McDonnell, Lockheed, North American, Republic, Fairchild, A. V. Roe, and Piasecki—all of them now large-scale ROTORette users.



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During the past year, our advertising has emphasized and re-emphasized one significant fact. For over thirty years, Bendix Products Division of Bendix Aviation Corporation has employed the largest group of trained specialists in the fields of fuel metering, landing gear, wheel and brake equipment to be found anywhere in the aviation industry.

It is indeed a story well worth repeating for obviously out of this vast reservoir of specialized experience can come better designed products, lower cost and on-schedule production.

It is in fact the principal reason why leading air frame builders and engine manufacturers turn to Bendix Products for the best solution to their fuel metering, landing gear, shock absorbing strut, wheel and brake problems.

Bendix Products Division

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ENGINE FUEL SYSTEMS Fuel metering controls for jets and ram jets, injection and float type carburetors, direct fuel injection systems.

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A general view of the technical capacities of the CPE Producing Companies is given in the chart. But the chart cannot show the very close interrelation of these capacities nor the highly flexible application of facilities, techniques and capabilities which exists among these companies. This is achieved through GPE's basic operating policy—Coordinated Precision Technology.

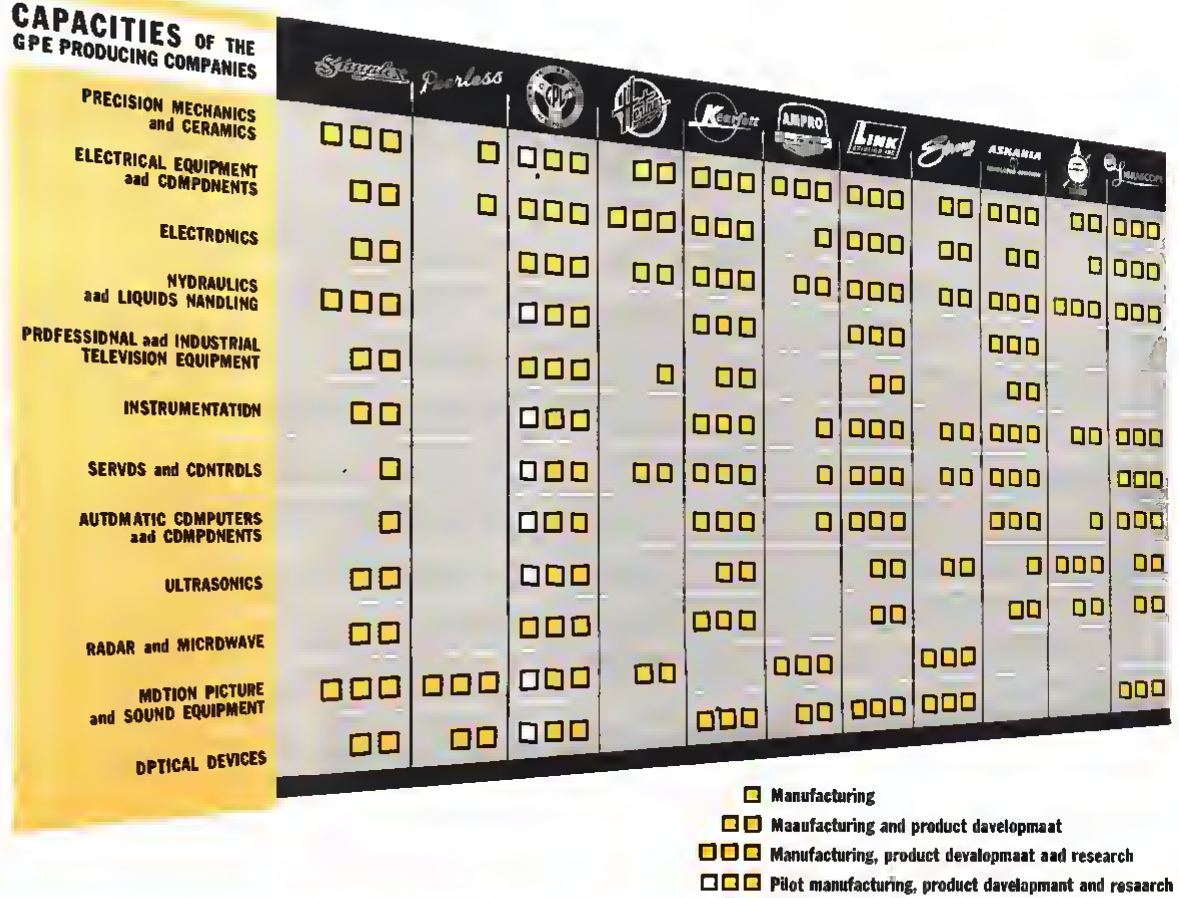
CPE Coordinated Precision Technology operates in all areas—in research, development and manufacture. The record of the GPE Producing Companies in solving advanced technological problems and meeting the demand for high speed, precision, reliability, light weight and compactness at competitive prices is the result of this coordination, the constant application of the newest and most highly advanced techniques, and unremitting insistence on highest quality.

Perhaps the most conspicuous advantage of GPE Coordinated Precision Technology is that the concept and development of equipment and systems, and of solutions to the underlying technical problems, are not restricted by being confined to the specialized techniques of a particular field. In short, GPE Coordinated Precision Technology permits each company to seek the optimum solution for the customer by the application of all relevant techniques within the total capacities of the entire group. Address inquiries to:

GENERAL PRECISION EQUIPMENT CORPORATION
92 GOLD STREET, NEW YORK 38, NEW YORK

Over **2200** scientists, engineers, draftsmen, testers and other technical personnel in the GPE Companies work in the fields covered by this chart.

CAPACITIES OF THE GPE PRODUCING COMPANIES



- Manufacturing
- Manufacturing and product development
- Manufacturing, product development and research
- Pilot manufacturing, product development and research

THE GPE PRODUCING COMPANIES

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- Poorless — J. E. McAUSLEY MFG. CO. CHICAGO
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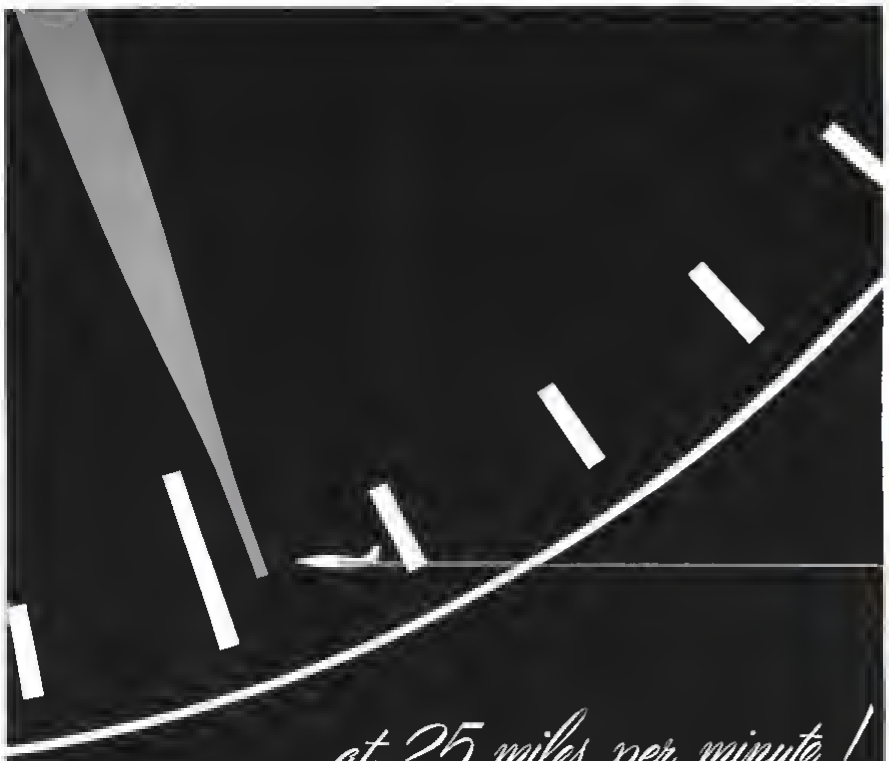

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By means of intricate electronic instruments, Link re-creates all of the Banshee's flight characteristics. U. S. Navy pilots learn jet fighter tactics and aerial combat at sub-sonic speeds. They practice carrier landings and take-offs, learning to know their plane so completely that even their first actual flight will seem almost routine

Once again, Link keeps pace with progress, helping our armed forces to defend America

Developed under basic Link patents, the F2H-2 and F2H-3 Jet Flight Simulators are used in stationary and mobile units to help U. S. Navy pilots train for jet flight.

LINK INVITES APPLICATIONS FROM QUALIFIED ENGINEERS AND DRAFTSMEN

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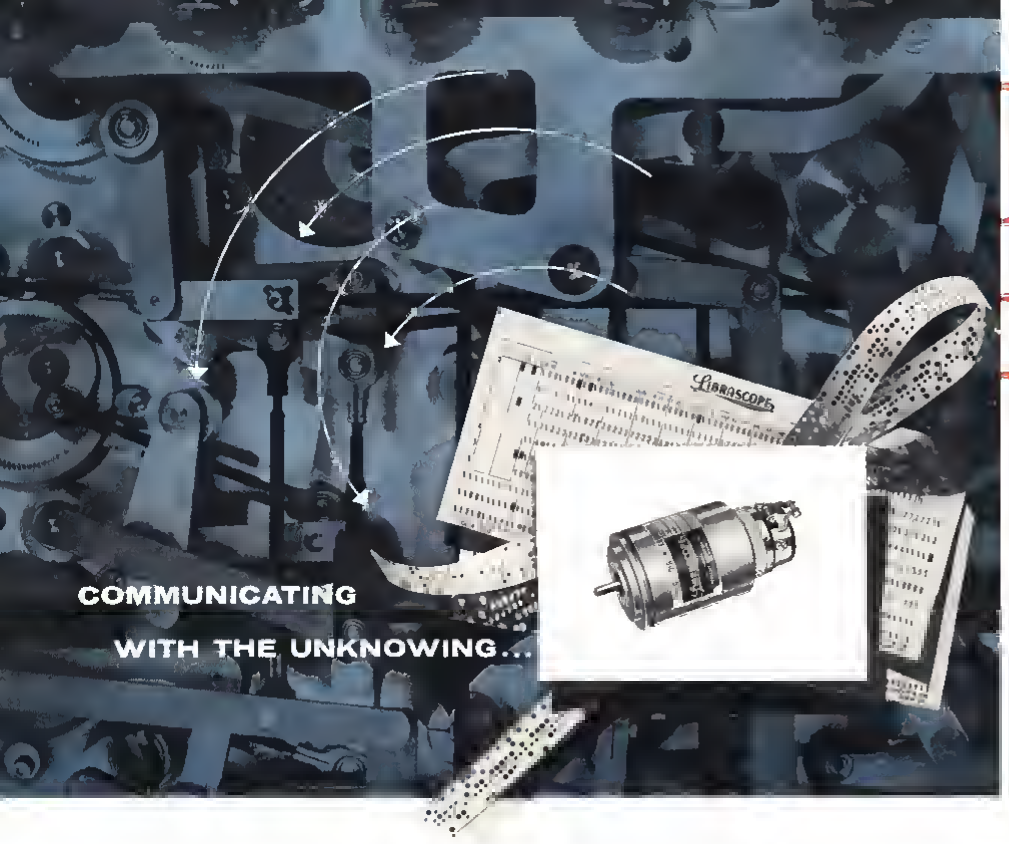

Your problem in Electronic Systems Design

A major problem in electronic controls systems design is how to get information into and out of machines, because machines, like people, do not always speak the same language. Thus devices must be created solely to convey information between machines. A good example of this is the Librascope-designed analog-digital converter which translates mechanical motion into electronic codes. Other Librascope devices provide similar avenues of information, making it possible to communicate with machines, processes, and understand heretofore unintelligible phenomena. Librascope components are packaged in sub-assemblies which are then combined into control and data-handling systems for commercial and military projects. These devices can also be assembled into a myriad of different configurations, many of which may be applicable to your particular problems. Write today for details.

Librascope also manufactures mechanical and optical control devices and computers. Send for booklet describing our company.

Engineers in search of interesting assignments, security advancement—contact Mac McKeague, Personnel Director

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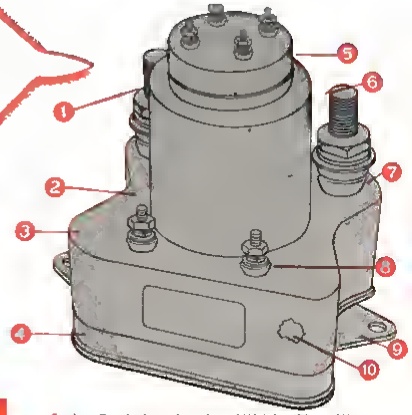
Cutler-Hammer Hermetically Sealed Relays



1. Low Terminals cut Length and Weight of Lead Wires—Interchangeable with Class O Relays. 2. Coil gives Maximum Heat Transfer. 3. Low Center of Gravity. 4. Completely Environment-Proof—Non-Corrosive and Fungus-Proof. 5. N.O. & N.C. Auxiliary Contacts Available. 6. Wide Terminal Spacing. Socket Wrench Clearance. 7. High Dielectric and Recovery of Glass. 8. No 6 Studs allow Some Lead Wiring as Unsealed Class O Relays. 9. Single Pole Relay Mounting Permits Easy Replacement of Unsealed Class O Relay with New Design. 10. Operchlis with Hole in Case. Does Not Rely on Artificial Atmosphere

Setting new standards for dependability in electrical control for aircraft

C-H Class A Relay operates in ambient temperatures up to 71° C. No Auxiliary Contacts.

C-H Class B Relay operates in ambient temperatures up to 120° C. Available with auxiliary contacts.

Both Class A and Class B Relays meet the requirements of "Report of Advisory Staff for Aircraft Electrical Systems—April, 1951". Operate at 60,000 feet. Class A withstands vibrations 10 to 500 cps, 10 g. Class B to much higher than 500 cps. Light weight design. Continuous duty coil.

The new Cutler-Hammer Hermetically Sealed Aircraft Relays are the culmination of years of intensive development and research by Cutler-Hammer engineers in close cooperation with leading aircraft builders. They meet the present and future need for environment-free devices for use in higher ambient temperatures with the ability to better withstand shock and vibration. They offer longer trouble-free life and contribute directly to increased safety.

Only permanent non-aging materials are used in these new relays. All metal parts (except those carrying current or those in the magnetic structure) are stainless steel. The stainless steel case is covered *both outside and inside* with a specially developed blue glass fused thereto at extremely high temperatures. This glass was developed to have the same coefficient of expansion as the metal to which it is bonded, is chip-proof under even rough handling, and has great dielectric strength with maximum recovery should a flashover occur. Special high-strength terminals are used, glass-bonded to case. Cases are filled with a special inert gas and are 100% inspection-tested by the mass spectrometer method for a positive hermetic seal.

These new relays have been standardized to be generally interchangeable with presently-used unsealed relays. This Cutler-Hammer line is also being extended continuously as to types and capacities available. Be sure you have the latest data and are listed to receive promptly all new information as it is released. Write or wire today. CUTLER-HAMMER, Inc., 1471 St. Paul Avenue, Milwaukee 1, Wisconsin.

What you should know about Cutler-Hammer

Cutler-Hammer has long held the respect of the aircraft industry because this company has been *part* of the aircraft industry for 35 years. It has never been an opportunist supplier. It has *pioneered* the designs others have followed. It has sought to serve, not merely sell. It has been in the forefront of all cooperative activity in standardization and long-range planning. It has supplied complete *lines* of equipment, not merely the items of widest use and most profitable manufacture. Today, as for the decades past, Cutler-Hammer engineers are working closely with the aircraft industry's leaders, thinking ahead, planning, designing and building for the future. Here is the record:

1920 Cutler-Hammer designed and manufactured the first line of switches ever created specifically for use in aircraft.

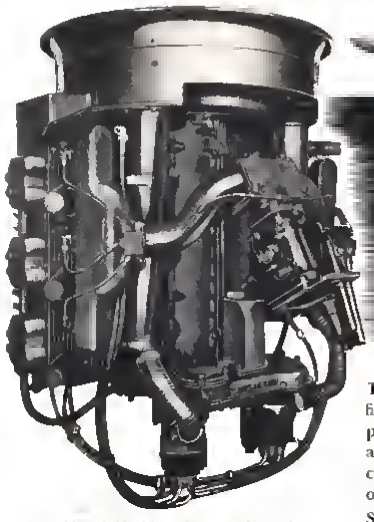
1938 Cutler-Hammer designed and manufactured the first d-c power relay ever created specifically for use in aircraft.

1943 Cutler-Hammer designed and manufactured the first a-c power relay ever created specifically for use in aircraft.

1949 Cutler-Hammer started development of the first environment-free power relays for use in aircraft.

1953 Cutler-Hammer submitted samples and certified test reports on the first hermetically sealed power relay to WADC and Bu. Aer. Cutler-Hammer configuration adopted as industry standard by ASG.

CUTLER-HAMMER
AIRCRAFT CONTROL
C-H



Franklin 0-425-13 turbosupercharged engine, with engine driven fan, integral cooling air system and dry sump lubrication system, for approximate vertical installation in helicopters. Adaptable for horizontal installation by minor changes in oil system

Franklin

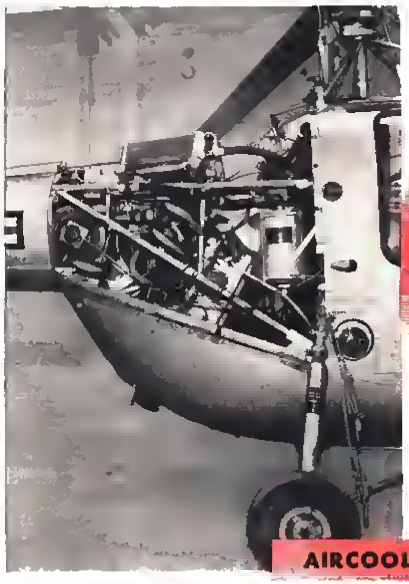
A new compound-type piston engine

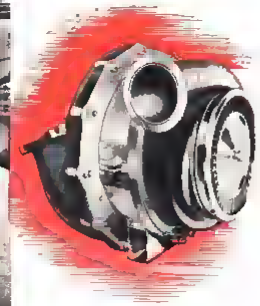
of unmatched efficiency in the small engine field

This new Franklin 0-425-13 turbosupercharged engine, as qualified for the U.S. Army Transportation Corps, produces a take-off power rating of 300 BHP from sea level to 10,000 ft. altitude and a normal rating of 285 BHP from sea level to 12,300 ft. In calibration tests, performance in excess of 400 BHP has been obtained at sea level standard conditions.

Specific weight of the engine-turbo combination for helicopter or submerged installation is only 1.55 lb/hp, and for fixed wing aircraft only 1.43 lb/hp. Fuel consumption is notably low — .55 lb/BHP/Hr. S.L.T.O.

The combination of superior altitude performance, low specific weight and fuel economy offered by this power package results in increased payload and greater range whether installed in a helicopter or in a conventional fixed-wing aircraft. We will be happy to discuss specific applications with interested airframe manufacturers.





Turbosupercharger designed and developed by Aircooled Motors for the Franklin 0-425-13 engine. Will supply 40" of mercury absolute pressure at carburetor inlet up to 16,000 ft. altitude. Adaptable for engines up to 400 HP and with modifications to engines of 200 HP. Weight only 36 lbs.

Franklin 0-425-13 complete power plant (engine turbo and regulator) installed in Army H-18 helicopter shows compactness and adaptability to existing airframes.

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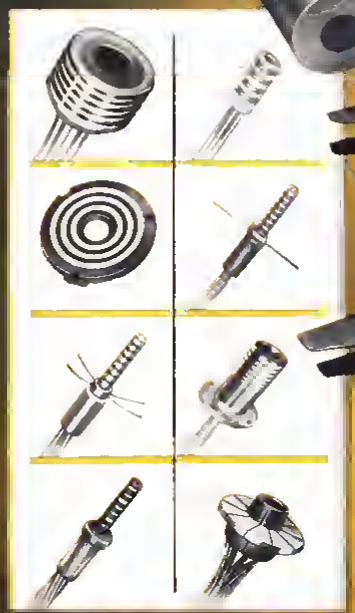

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- SIZES: .035" to 36" Diameter, Cylindrical or Flat
- CROSS-SECTIONS: Ring Thickness .005" to .060" or More
- FINISH: 4 Micro-Inches or Better
- BREAKDOWN: 1000 V or More Hi-Pot Inter-Circuit
- RING HARDNESS: 70 to 95 Brinell
- SURFACE PROTECTION: Palladium and Rhodium, or Gold Prevent Tarnish, Minimize Wear & Noize

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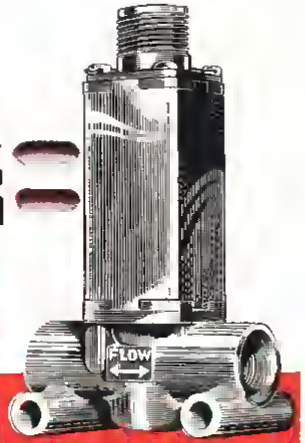
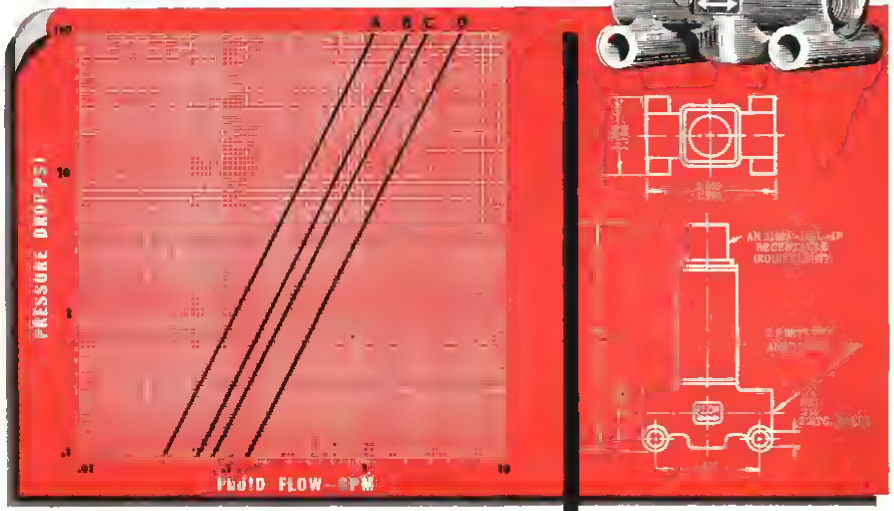
FLOW *Maximum* = WEIGHT *Minimum*





TABLE

Valcor Valve Part No.	Type	Max. Operating Pressure	Flow Characteristics
V-3800	Normally Open	200 psig	See Curve D
V-3900	Normally Closed	100 psig	See Curve D
V-6800	Normally Open	300 psig	See Curve C
V-8400	Normally Closed	200 psig	See Curve C
V-8500	Normally Open	300 psig	See Curve B
V-5000	Normally Closed	300 psig	See Curve B
V-8300	Normally Open	500 psig	See Curve A
V-7000	Normally Closed	500 psig	See Curve A

SPECIFICATIONS:

- WEIGHT—⅓ lbs
- AMBIENT TEMPERATURE—minus 65° to plus 180° F
- MAX LEAKAGE—½ cc/hr fuel 10 cc/min air
- CURRENT DRAIN—½ amperes @ 24 V D C

Designed in accordance with MIL-V-8610 (ASG) and MIL-E-3009A

NEW VALCOR SOLENOID VALVES

with the highest ratio of flow to weight of any valve made. They are low in weight (⅓ lb.), low in pressure drop (see chart), low in power consumption (½ amp at 24 V D C), [illegible] and low in cost. No other Solenoid Valve but VALCOR is so completely depended upon in so many critical applications.

VALCOR
Solenoid Valves

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East Coast Engineering Co.
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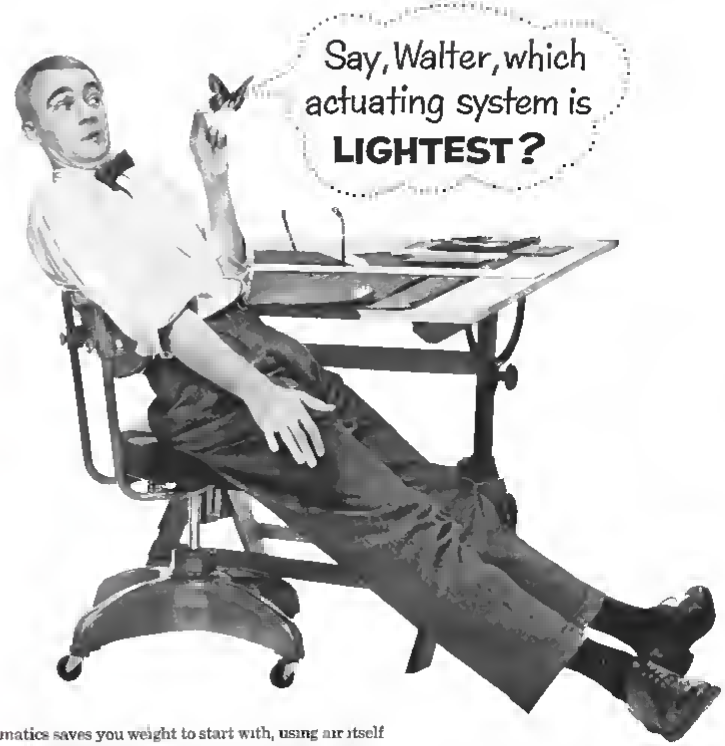
2140 Westwood Blvd.
Los Angeles 25, Calif.

VALCOR ENGINEERING CORPORATION CARNEGIE AVE., KENILWORTH, NEW JERSEY



Pneumatics saves you weight to start with, using air itself as a medium! *More* pounds are saved by the smaller lines used in pneumatic systems — and no *return* lines are required!

Even the heart of a pneumatic system is light — the new Kidde 4-D compressor, for instance, delivers 4 cfm of air compressed to 3000 psi at sea level — yet weighs only 11¼ pounds!

With pneumatics, you can build up a high-pressure, high-horsepower punch, using this low-horsepower, lightweight source. Just *store* the air-power until you need it — even using landing gear struts and other parts of the aircraft itself!

Since viscosity of the air used in pneumatic systems remains essentially the same over a broad temperature range (—65° to +250°), you *always* get fast, dependable power delivery. Pneumatic systems are *never* sluggish!

With pneumatics, leakage is no serious problem. The air supply is always available, and the compressor compensates for any minor leaks which might occur. And since the air used in the system cannot burn, there is no danger from fire!

We here at Kidde have a *complete* line of pneumatic system components, as well as facilities for engineering complete pneumatic systems. If *you* have a problem in pneumatics, please write us.

Kidde
FOR PNEUMATICS

Walter Kidde & Company, Inc., 318 Main Street, Belleville 9, N. J. • **Walter Kidde & Company of Canada, Ltd., Montreal—Toronto**

Eastern adds a New Constellation to the Skies!

. . . Once again Sinclair is chosen for dependable engine lubrication...this time, for the Super-C.

The newest member of Eastern's Great Silver Fleet has taken to the skies. The latest in Constellations, Eastern Air Lines' SUPER-C is designed to give Eastern passengers faster service with the same dependability proven over *billions* of passenger miles.

As with every airline, Eastern stresses reliable performance – brought about by dependable products. Proof of the aviation industry's confidence in Sinclair may be found in the fact that *45% of the aircraft oils used by major scheduled airlines in the U. S. is supplied by Sinclair.* Why not place *your* confidence in Sinclair Aircraft Oil?

SINCLAIR AIRCRAFT OILS

SINCLAIR REFINING COMPANY, AVIATION SALES, 600 FIFTH AVENUE, NEW YORK 20, N. Y.

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Not only this plant with its precision production equipment ... not only the laboratories with their intricate testing facilities ... but, above all, the abilities and the brains of the men of Greenleaf are at your service To utilize our unusual development, engineering and manufacturing experience ... we solicit the kind of projects that make others hesitate

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ENGINEERING • DEVELOPMENT • PRODUCTION

Where quality control works on the production line ... producing Gyros (rate and integrating), Pressure Transmitters, Accelerometers, Synchros, Air Speed Indicators, Actuators and many other precision built components.

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THE Greenleaf MANUFACTURING COMPANY
7814 Maplewood Industrial Court • Saint Louis 17, Missouri

setting new standards for transparent enclosures

PLEXIGLAS 55

First used in 1952 for windows of the Douglas DC-6, PLEXIGLAS 55 was next specified for cockpit canopies of the Boeing B-47, shown above Today this improved grade of aviation's standard transparent plastic is being used on more and more types of military and commercial planes

Current production aircraft using PLEXIGLAS 55 include:

Boeing B-47	Douglas DC-7, DC-6B, DC-6
Cessna T-37	Lockheed F-104
Convair F-102	Martin B-57B
Douglas A4D	North American F-100

PLEXIGLAS 55 is characterized by notably improved craze-resistance and a higher maximum useful service temperature Combined with the traditional clarity, formability and weathering properties of PLEXIGLAS acrylic plastic, these advantages provide significantly longer service life for transparent enclosures on current production aircraft For the planes of the future, we are working to raise the quality of transparent plastic to an even higher level

PLEXIGLAS is a trademark, Reg U.S. Pat. Off., and in other principal countries of the Western Hemisphere.

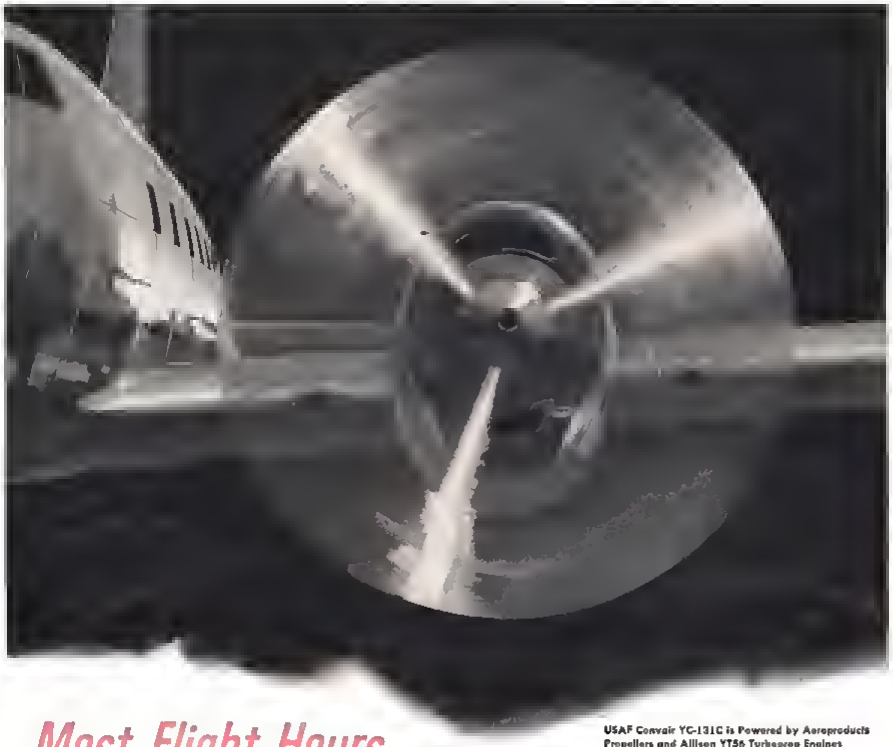
CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

CANADIAN DISTRIBUTOR *Crystal Glass & Plastics, Ltd., 130 Queen's Quay at Jarvis Street, Toronto, Ontario, Canada.*



USAF Convair YC-131C is Powered by Aeroproducts Propellers and Allison YT56 Turboprop Engines

Most Flight Hours... Greater Reliability!

AEROPRODUCTS HAS MORE TURBOPROP EXPERIENCE THAN ANY OTHER U. S. MANUFACTURER

AIR-DRIVEN GENERATOR

TURBOPROP

AIR-DRIVEN HYDRAULIC PUMP

ACTUATORS FOR AFTERBURNERS

General Motors engineering leads the way

GM MOTORS

Building for today...Designing for tomorrow

Aeroproducts

ALLISON DIVISION OF GENERAL MOTORS • DAYTON, OHIO

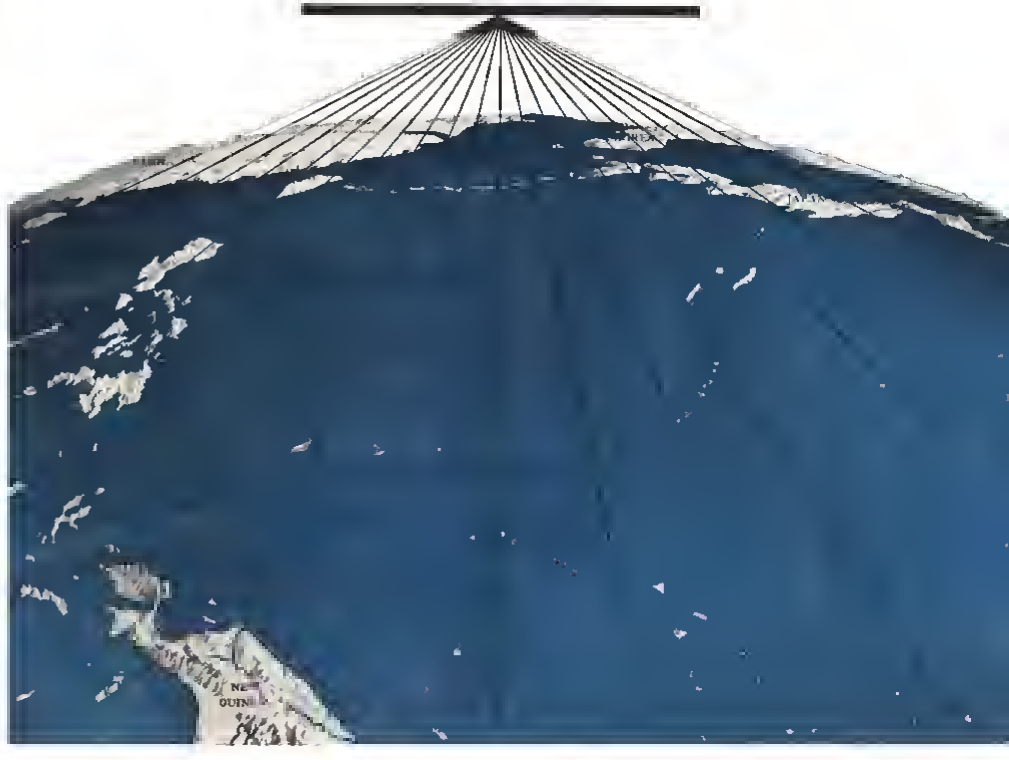
Clearly, the big trend in transport aviation today is toward powerful turboprop engines and propellers. This combination enables both military and commercial aircraft to carry bigger payloads farther, faster, and more economically than ever.

And most importantly, turboprop engines equipped with Aeroproducts turbopropellers combine high power with low weight—features important in aircraft design and in airline operation.

Today, Aeroproducts turboprops are America's most widely used because they have proved their quality and stamina on the Allison Turboliner, the USAF Convair YC-131C, and other military aircraft. They are backed by more flight hours than any other American-made turbopropellers.

Whatever your design demands, you'll find Aeroproducts ready to meet your most detailed specifications—not just for turbopropellers, but for all propellers requiring high horsepower absorption. Also available are actuators, air-driven generators and air-driven hydraulic pumps, with other aircraft components still under development. Call or write us for details.

bases unlimited



The recent unveiling of the United States Navy's new 4 jet waterbased aircraft, the Martin XP6M Sea Master, has focused attention upon one of the most important discussions in America today The Water-based Aircraft concept.

In essence, you are looking at that discussion in the piece of our world shown here It is a glimpse of the countless free and indestructible water bases available throughout the eastern Pacific area.

Did you know that . . .

. . .The SeaMaster has global range, operating from the seaways, lakes and navigable rivers of the world — water bases that are within a few miles of virtually any area on earth.

. . .The SeaMaster is Ship No. 1 of a new aircraft *type*. In speed it is in the over 600 m p h class, and it spearheads a whole new arm of the naval arsenal — the Seaplane Striking Force.

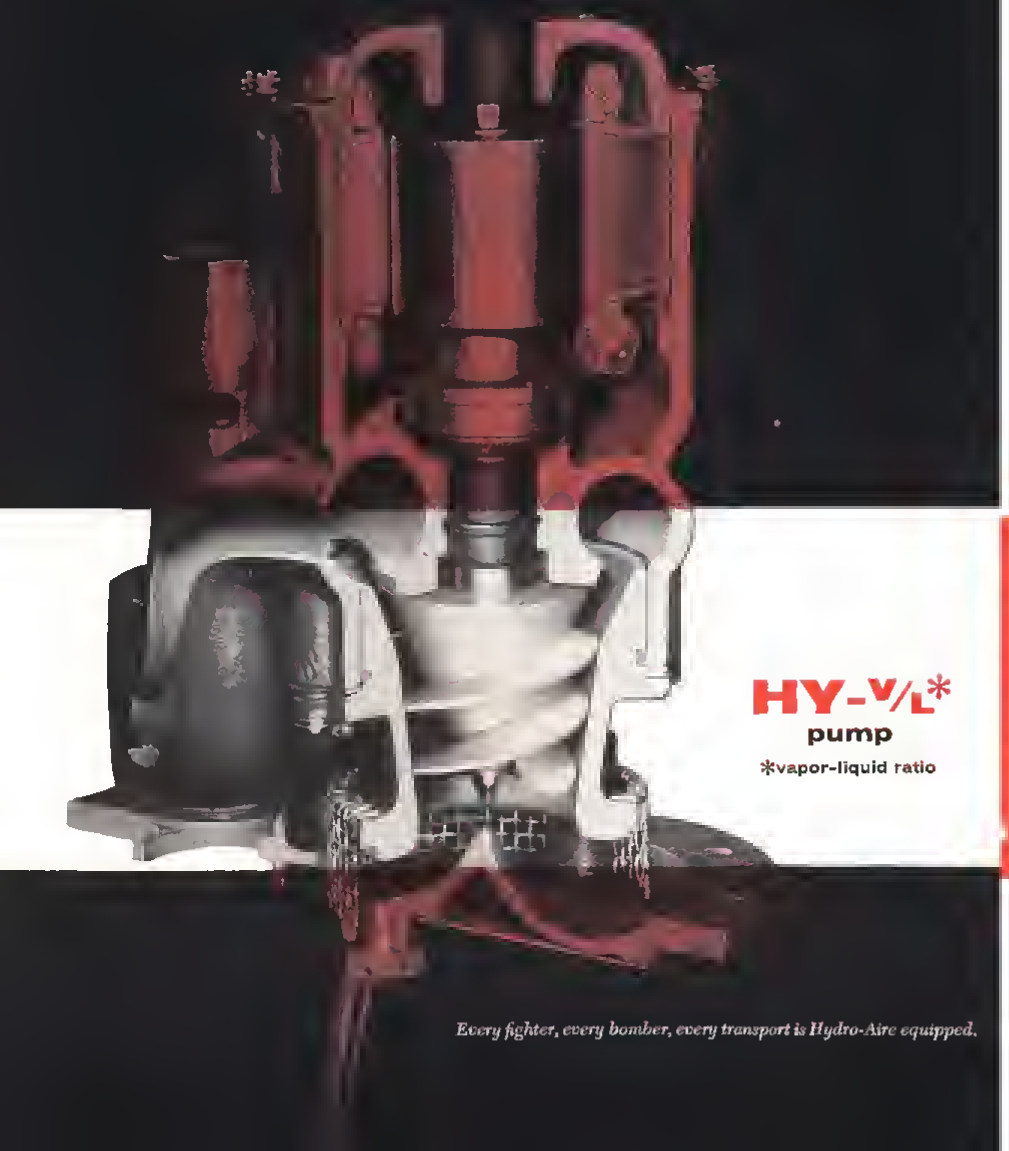
. . .The SeaMaster is not a research airplane, but the prototype of an operational weapons system designed to remain on duty for extended periods anywhere in the world For the Navy program includes facilities for off-shore maintenance, refueling and resupply which give it a mobility never before possible in military aircraft.

To American security the SeaMaster now offers *bases unlimited!*

MARTIN

BALTIMORE · MARYLAND

Puzzle for Fuel Booster Pump Experts:



HY-V/L* pump

*vapor-liquid ratio

Every fighter, every bomber, every transport is Hydro-Aire equipped.

? FIND THE VAPOR SEPARATOR

The opposite page shows a cutaway of Hydro-Aire's HY-V/L Fuel Booster Pump. Model 6227.

Here are the advantages this pump offers:

- It is lighter, less complex and more compact.
- It is more efficient . . . *uses less power* . . . gives excellent overall climb performance.
- It recovers immediately, even after a momentary power failure or inlet unporting.
- It works equally well with different types of fuel . . . or even with contaminated fuel.
- Most important. The HY-V/L has *design predictability*. That means it can be tailored to meet your exact requirements. We can actually provide you with a simple set of charts that will enable you to determine weight, power requirement, size . . . all the important specifications for your particular application.

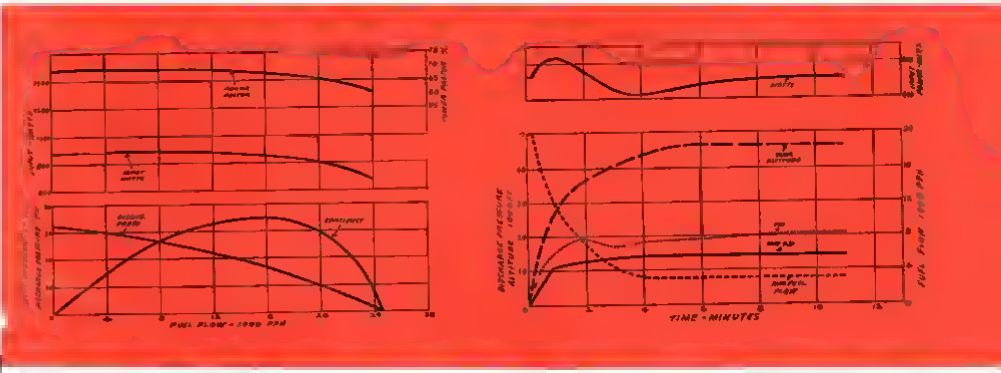
All these advantages stem from the fact that the HY-V/L design completely eliminates the old vapor separator used in conventional fuel booster pumps. This is done by compressing the fuel vapors back into the liquid *inside the pump*.

Yes, the most startling feature of Hydro-Aire's HY-V/L Fuel Booster Pump is something that isn't there!

PERFORMANCE CURVES OF HY-V/L PUMP, MODEL 6227

AT SEA LEVEL
POWER: 3 Phase 400 c. 200 V. AC.
FUEL: MIL-F-5624A (JP-4), 61°F.

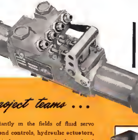
AT ALTITUDE
POWER SOURCE: 200 Volts/400 CPS.
FUEL: MIL-F-5624A (JP-4).



HYDRO-AIRE Inc.
3000 WINONA AVENUE, BURBANK, CALIF.
The Aviation Subsidiary of CRANE Co.

NWL—a top aircraft accessory team 100% engaged in design, development, and precision production of aircraft equipment and accessories.

QUALITY CONTROLS . . . *The Lift* LINE

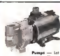


Fluid Servo Mechanisms—Designed to operate airframe controls in highspeed aircraft, these servo actuators may be single or dual system types—mechanically, electrically, or multi input actuated

NWL *project teams* . . .

working constantly in the fields of fluid servo mechanisms and controls, hydraulic actuators, electro-mechanical components, and other related aircraft accessories—have built years of experience and "know-how" into the Lift line of products. NWL project teams are immediately available to assist you on your control program . . . from design thru quantity production or any portion to fit your needs.

Constant Performance Electro- Servo Valves Direct and pressure operated.



Pumps — Let us prove the advantages of NWL pump "know how"—spur gear—internal gear—vane—and centrifugal.

Directional or Pressure Control Valves — Electrical or manual — direct or pilot operated.

Contact the NWL resident engineer in your area.

OTHER LIFT LINE PRODUCTS

- Screwjacks—Ball and Acme Thread
- Synchronized and Hi-temperature Actuators
- Pneumatic Actuators and Valves
- Mechanical Devices
- Precision Sub Contract Manufacturing

Electro-Mechanical Actuators, ask for data on the full Lift line

NATIONAL WATER LIFT COMPANY

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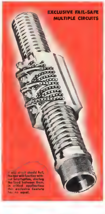
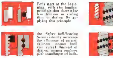
The Lift

HERE'S A BETTER ACTUATION METHOD!

Saginaw ball/bearing Screws can help you solve weight, power and temperature problems



WHAT IT IS AND HOW IT WORKS



Let's start at the beginning with the familiar principle that there is less friction in rolling than in sliding. By applying this principle

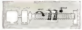
the *Safety ball/bearing Screw* radically increases the efficiency of rotary to linear motion (and vice versa). Instead of sliding, motion enforces glide on rolling steel balls.

Like stripes on a barber pole, the balls travel in ... through spiral "tunnel" formed by common threads in both screw and mating nut

At end of trip, one or more tubular guides lead balls diagonally back across outside of nut to starting point, forming closed circuit through which balls recirculate

TREMENDOUS ADVANTAGES IN AIRCRAFT ACTUATION

Conventional Acme screw's efficiency is less than 25%. *Safety ball/bearing Screw's* ranges from 90 to 95%! Combined with electric, hydraulic or pneumatic power source, it forms an actuator for aircraft (and similar uses) that



SAVES WEIGHT—permits use of smaller motors and gear boxes, eliminates pumps, accumulators, piping, etc.

SAVES POWER—*Safety b/b Screw* requires only 1/3 as much torque for same linear output as conventional Acme screw

SOLVES TEMPERATURE PROBLEMS—operates successfully from −75°F to +900°F—and without lubrication, if needed.

ASSURES POSITIVE POSITIONING—permits precision control within thousandths of an inch; gives perfect synchronization

INCREASES DEPENDABILITY—offers longer life and added security of exclusive multiple circuits, plus greatly decreased dirt sensitivity of special Gothic arch shaped races

REDUCES PART AND INSTALLATION COSTS—savings in weight, maintenance, power and auxiliary equipment cut cost, too

ANY SIZE FROM 1½ INCHES TO 39½ FEET IN LENGTH

Every *Safety b/b Screw* is individually engineered for its particular application. Our engineers are eager to help solve your actuator problems now.

MAIL COUPON TODAY FOR YOUR ENGINEERING DATA BOOK

(or see our section in Sweet's Product Design File)

Saginaw Steering Gear Div.
General Motors Corp
Dept. 2E, Saginaw, Michigan
Please send your Engineering Data Book to

Name—Title ....
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Address ....
City .... Zone .... State ....

Safety ball bearing Screw by *Saginaw*

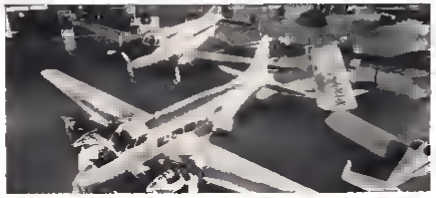
They come from thousands of miles for Reading's unsurpassed service!

New prop shop is CAA Approved for servicing of Hamilton Standard and Hartzell propellers. In foreground is Supervisor Ed Heine who puts 16 years' prop experience into every job.

Reading Aviation Service Attracts Industrial, Executive, And Private Aircraft From All Over The Country For The Finest Servicing Available Today.

It is no accident that aircraft come from thousands of miles to benefit from the thorough one-stop servicing of Reading Aviation Service at Municipal Airport, Reading, Pa. Nor is it any accident that RAS uses Cities Service Aviation Products. Says President A. M. Bertolet: "A great deal of credit for our excellent reputation can be attributed to use of only the finest materials . . . materials such as Cities Service Aviation Products."

Sales and Service of DME Equipment is newest function of complete radio and electronics center. RAS is one of the very few companies in the U.S. chosen to sell and service both Narco and Bendix distance measuring equipment.



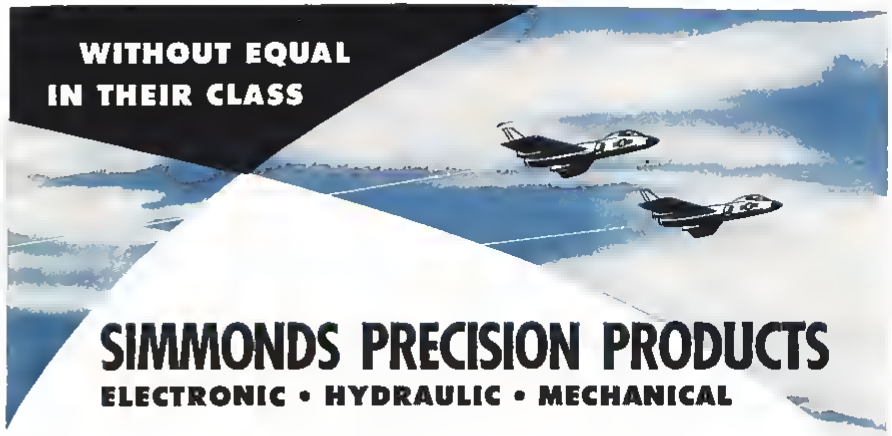
Most major inspections completed in a day. Here in the main hangar, a staff of 70 RAS specialists insure fastest, most dependable service. In foreground is twin-engine de Havilland for which RAS is sales agent.

2 Ways to gas-up with Cities Service Gasolene. Jeep truck for small aircraft, large tank-truck for bigger planes. "Cities Service Gasolene gives best performance," says RAS.

Filling Up with Kendmotor Aero Oil. RAS uses only new Kendmotor because, says Pres. Bertolet, "We've found it reduces oil consumption, valve guide wear and gives better engine protection."

CITIES SERVICE AVIATION PRODUCTS

New York • Chicago • In the South: Arkansas Fuel Oil Corp.



SIMMONDS PRECISION PRODUCTS

ELECTRONIC • HYDRAULIC • MECHANICAL

Famous as first in the development and manufacture of a growing list of advanced aircraft accessories, Simmonds offers the U. S. aviation industry a proven source for specialized electronic, hydraulic and mechanical components and systems.

LIGHTWEIGHT PACITRON FUEL GAGE SYSTEMS Fuel measurement and fuel management systems, of both the "two unit" and "three unit" types are now available in the famous Pacitron systems. With its gages now flying on more than 90 advanced type aircraft and on 40 U. S. and foreign flag airlines, Simmonds continues to be "first in electronic fuel gaging." Write for booklet "Fuel Gage Systems for Transport Aircraft."

SIMMONDS SU FUEL INJECTION SYSTEMS: The only advanced type fuel injection system now in production for medium h.p. gasoline engines, the SU System has been proven in field tests to give fuel economies up to 35%. Eliminates icing conditions, and gives improved cold starts. Detailed information available on request.

PRECISION PUSH-PULL CONTROLS: Simmonds Push-Pull Controls are positive, precise and versatile. Capable of heavy loads and accurate operation under vibration, continuous cycling, temperature extremes, etc. Proven in millions of miles of reliable service on aircraft engines, pressurized doors, helicopter controls, etc. Write for design literature.

COWLING AND ACCESS LATCHES: Heavy duty flush fitting aircraft latches for installation on cowlings and access panels. Two-piece toggle type construction, available to fit a wide range of structural curvatures. Portfolio of latch designs available on request.

EXPLOSION SUPPRESSION SYSTEMS: Designed to provide protection against the most common single cause of the loss of combat aircraft — explosions resulting from the ignition of fuel/air mixtures. Now flying on U. S. combat aircraft, this is another Simmonds first. Further information on request.

HYDRAULIC FUSES: Quantity measuring fuses that act as automatic safety shut-offs for aircraft hydraulic systems. Close whenever more than a predetermined amount of liquid passes through the line. Detailed information available on request.

Simmonds AEROCESSORIES, INC.

OTHER SIMMONDS SERVICES
For the full list of Simmonds products and information on engineering and manufacturing services, write to.

SIMMONDS CONTRACT AND SERVICE DIVISION
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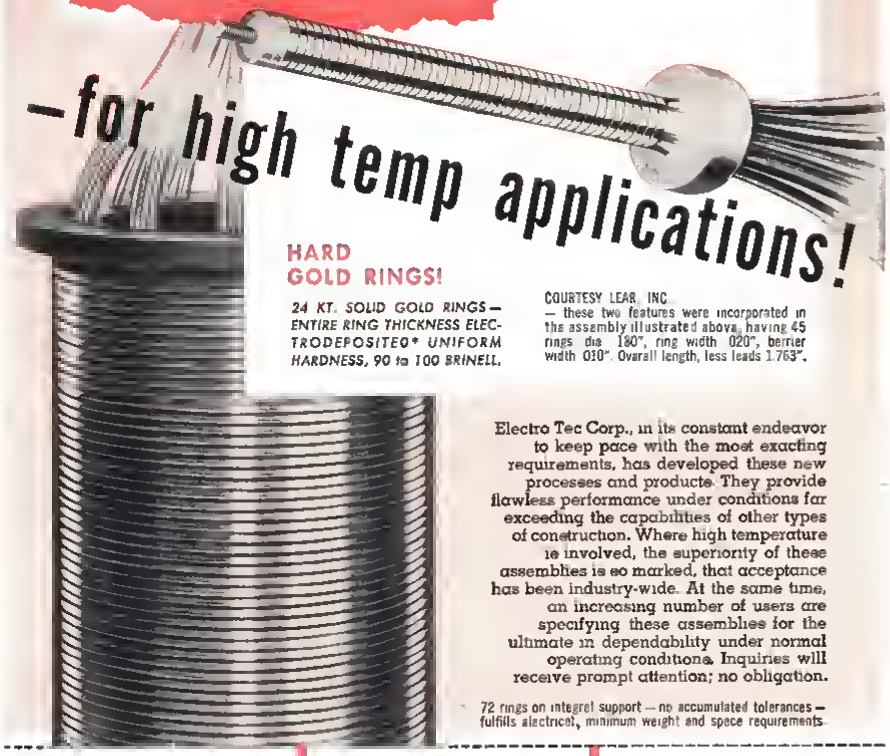
ELECTRO TEC SLIP RING ASSEMBLIES

At the I R E SHOW!
BOOTHS #133, 135 TELEVISION AVE.
Kingsbridge Armory, New York City
March 21-24, 1955

HIGH TEMP PLASTIC!

—for high temp applications!



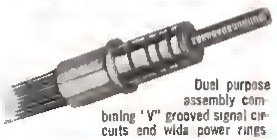
HARD GOLD RINGS!

24 KT. SOLID GOLD RINGS — ENTIRE RING THICKNESS ELECTRODEPOSITED UNIFORM HARDNESS, 90 to 100 BRINELL.*

COURTESY LEAR, INC.
— these two features were incorporated in the assembly illustrated above, having 45 rings dia. 180", ring width 020", barrier width 010". Overall length, less leads 1.763".

Electro Tec Corp., in its constant endeavor to keep pace with the most exacting requirements, has developed these new processes and products. They provide flawless performance under conditions far exceeding the capabilities of other types of construction. Where high temperature is involved, the superiority of these assemblies is so marked, that acceptance has been industry-wide. At the same time, an increasing number of users are specifying these assemblies for the ultimate in dependability under normal operating conditions. Inquiries will receive prompt attention; no obligation.

72 rings on integral support — no accumulated tolerances — fulfills electrical, minimum weight and space requirements.



Dual purpose assembly combining 'V' grooved signal circuits and wide power rings

Miniature high speed sampling switch — 24 channels

Combining low friction torque slip rings (.060 dia.) with reference switch segments

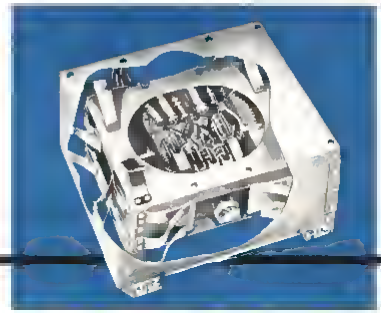
NEW ETC-7 (POLYESTER RESIN) WITHSTANDS TEMPERATURE RANGE FROM —60° to +500°F.

PRODUCTS OF PRECISION CRAFTSMANSHIP BY A NEW AND REVOLUTIONARY PROCESS

ELECTRO TEC CORP.
SOUTH HACKENSACK, NEW JERSEY

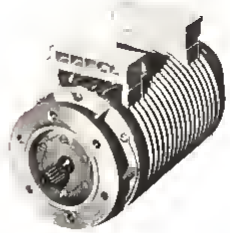
*PAT. NO. 2,696,570

"steady nerves"



In aircraft power generation

LELAND leads all others



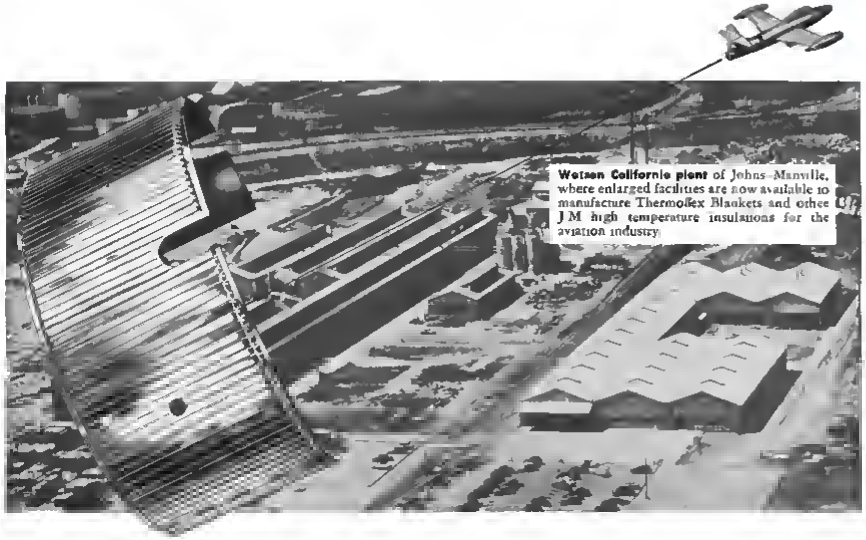
Has vibration, shock, or mounting position been a problem in your inverter application? To meet the latest specifications, Leland's creative engineers have invented a unique 3 dimensional spring mount that *isolates* the control from shock and vibration . . . allows steady inverter operation in *all* positions—*even upside down*

And in the field of A C generators and systems (where for 12 years Leland has specialized in high speed equipment, from 12,000 to 24,000 rpm), this same design skill and precision craftsmanship has been constantly at work.

Leland engineers are attacking the problems of reducing *alternator* size and weight, improving performance characteristics, to provide you with alternators, too, that meet the latest environmental requirements.

If you have an alternator need or problem, look to Leland. Take advantage of its 12 years of experience in the specialized airborne field—its firm policy of surpassing "satisfaction," making extra value the rule. Write THE LELAND ELECTRIC COMPANY, Division of American Machine & Foundry Company, Dayton 1, Ohio.

Another AMF Product
LELAND MOTORS



Watson California plant of Johns-Manville, where enlarged facilities are now available to manufacture Thermoflex Blankets and other J-M high temperature insulations for the aviation industry.

Johns-Manville expands production to make Thermoflex Insulating blankets

Precision-fabricated to your specifications, Thermoflex Blankets serve as insulations for tail pipes, engine cones, turbine casings and other assemblies. These blankets combine maximum stability, light weight and low thermal conductivity.

Backed by the World's largest insulation laboratory—located at the J-M Research Center, Manville, New Jersey. Both East and West Coast manufacturing facilities are co-ordinated with the design and technical services of this laboratory, to solve your thermal insulation engineering problems.

Enlarged facilities plus J-M insulation engineering service teamed to solve Aviation Industry's internal insulation problems

Johns-Manville has expanded its manufacturing operations to meet the aviation industry's increased demands for Thermoflex* Blankets. With its new production capacity at Watsonville, California—in addition to other manufacturing facilities at Manville and Roselle, New Jersey—Johns-Manville now has production facilities on both the West and East coasts.

These custom-made blankets, developed by Johns-Manville, have gained wide acceptance for insulating, protecting and fireproofing aircraft against the intense heat of jet power. Moreover, to meet present and future needs, other J-M high temperature insulations are available, and new and improved products are constantly being developed.

The aviation industry can also draw on the insulation design and engineering services offered by Johns-Manville. Through its technical personnel, Johns-Manville can help solve your thermal insulation problems and specify insulating materials tailored to your most exacting needs.

You can avail yourself of this complete insulation engineering service simply by calling the nearest J-M district office. Or write to Johns-Manville, Box 60, New York City 16, New York.

*Thermoflex is a Johns-Manville registered trademark

Johns-Manville PRODUCTS FOR THE AVIATION INDUSTRY

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FASTENINGS

mean greater pay loads

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Since titanium came out of the laboratory into production, airframe manufacturers have learned the amazing savings in weight that this metal can achieve—weight that may be translated into fuel for longer range or greater lifting capacity for personnel or cargo.

Today Harper offers manufacturers the skill, experience and facilities to fabricate all types of aircraft fastenings from titanium. If you are now using, or are considering using, titanium parts that require cold heading, roll threading, hot forging or milling, you will be interested in Harper's years of experience and the ability to solve any fastening problem.

Mail the coupon for information on fastenings of titanium or other high-temperature or corrosion-resistant metals.

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Aero Division
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Engineering data on Titanium Fastenings together with price list on standard size Titanium Bolts. Check the coupon.

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☐ Bulletin on Titanium Fastenings.
☐ High temperature fastenings.
☐ Corrosion-resistant fastenings.

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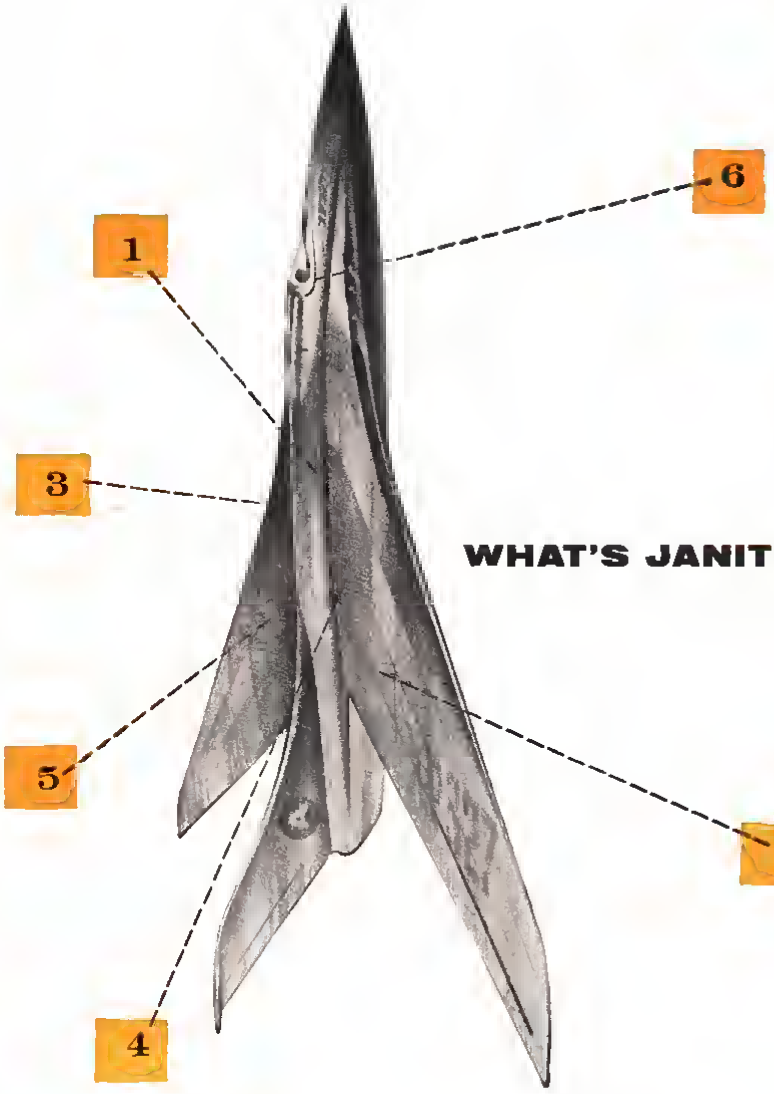


WHAT'S JANITROL DOING IN JETS?

1 *gas turbine combustion systems*

2 *gas turbine accessories*

3 *heat exchangers*

4 *inert gas generators*

5 *deaerating oil tanks*

6 *high pressure regulators*

If your projects involve increasing jet aircraft performance—to boost power without dry loss, to eliminate hot spots and thus achieve higher combustion rates, to develop new heat exchanger configurations—a call to Janitrol will give you a head start. Janitrol's specialized research and experience in combustion phenomena go back 50 years, and have resulted in such important developments as the Post-Turbine burner, automatic inert gas generators for inerting fuel cells, and the waffle plate principle of heat exchanger construction which improves heat transfer efficiencies and saves weight by getting the most out of metals.

It's a good idea to call in your Janitrol representative early in the design stage. He's always at your service.

50 years experience in combustion engineering

Janitrol

AIRCRAFT-AUTOMOTIVE DIVISION
SURFACE COMBUSTION CORPORATION
Columbus 16, Ohio

District Engineering Offices: New York, 225 Broadway, Washington, D. C., 4650 East-West Highway, Philadelphia, Penna., 401 No. Broad St.; Kansas City, Mo., 2203 Grand Ave.; Fort Worth, 2509 Berry St.; Hollywood, Calif., 7046 Hollywood Blvd.; Columbus, Ohio, 400 Dublin Ave.

DOW CORNING CORPORATION

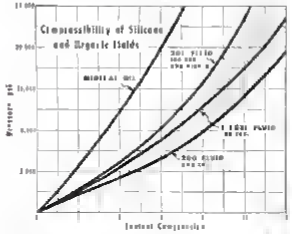
Silicone News

FOR DESIGN ENGINEERS

DESIGNERS USE SILICONE FLUIDS FOR MORE EFFICIENT SPRINGING

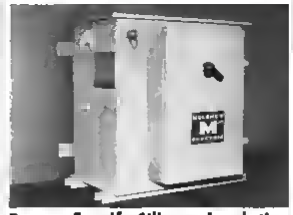
Dow Corning silicone fluids have always been noted for their thermal stability and their remarkably flat viscosity-temperature slopes. They have, therefore, been widely used as damping media in such devices as dashpots, overload relays and torsional vibration dampers for crankshafts.

More recently, designers have found that certain silicone fluids, Dow Corning F-4029 and some Dow Corning 200 Fluids, also have high compressibility. Using these fluids, engineers have produced liquid springs and shock absorbers with the same capacity as much larger and heavier metal coil springs. Testing indicates these highly compact liquid springs retain a high order of efficiency even under constant recycling at mill second intervals.



As shown in the graph, both Dow Corning F-4029 and the Dow Corning 200 Fluids are more compressible than the mineral oil commonly used in liquid springs. At 20,000 psi F-4029 has a compressibility of 10.8% which is mid-way between that of Dow Corning 200 Fluids of the same and of lower viscosity grades. While it lacks the compressibility of the lower viscosity 200 Fluids, Dow Corning F-4029 is less volatile and has a lower viscosity temperature coefficient. *No. 29*

New 1955 Reference Guide to Dow Corning silicone products gives in 8 pages a brief but comprehensive summary of the properties and applications for the silicone products that are most widely used. Products are indexed by type of application. With increasing effort devoted to product improvement and cost reduction, such a reference guide to this remarkably stable group of engineering materials becomes increasingly important to design engineers. *No. 30*



Buyers Specify Silicone Insulation for Greater Safety in Transformers

Safety conscious plant planners are swinging to silicone insulated, nitrogen filled transformers for greater protection against fires and explosions. New evidence of this growing trend is the order for over three hundred 30 KVA, 3 phase, dry-type units recently received by Moloney Electric Company of St. Louis. Designed for lighting and small motor service, these transformers are completely insulated with silicone materials to withstand abnormally high ambient or overload temperatures. *No. 31*

Silicone Resin Makes Wire-wound Resistors More Moistureproof

The Tru-Ohm Division of the Model Engineering and Manufacturing Co., of Chicago, has improved its line of wire-wound resistors by using a silicone-based cement that is much more resistant to moisture than the silicate-type cements previously used.

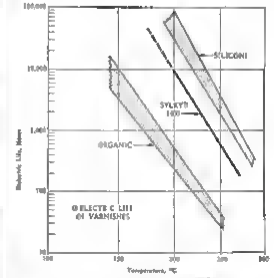
They make this cement by blending Dow Corning 996 silicone varnish with appropriate inorganic fillers. The material builds up well on the resistance wire and seals the element into the casing. It is set by air drying for 3 hours and then baking for 3 hours at 450 F.

Tru-Ohm produces the new resistors in 10, 15, 20 and 25 watt ratings for top-of-chassis mounting, and in 5, 7 and 10 watt ratings for axial leads. *No. 32*

New Silicone Varnish Improves Performance of Class B Machines

Sylkyd* 1400, a new modified silicone dipping and impregnating varnish, makes possible the production of more durable, more reliable Class B electrical equipment. Highly resistant to heat, it also has excellent bond strength and outstanding resistance to moisture, oil and degreasing solvents.

Accelerated life testing in our motor test laboratory indicates that the insulating life expectancy of Sylkyd 1400 at a hottest spot temperature of 130 C is 25 to 50 times that of Class B varnishes. As shown in the graph, the dielectric life of this new varnish approaches that of straight silicone (Class H) varnishes.



Sylkyd 1400 appears to be particularly useful on railroad traction motors and other heavy duty equipment subject to heavy overloads and periodic cleaning. Costwise, it is less expensive than Class B varnishes when the extra life and reliability are taken into consideration. *No. 33*

*T.M. REG. U.S. PAT. OFF.

Design Edition 7

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Midland, Michigan

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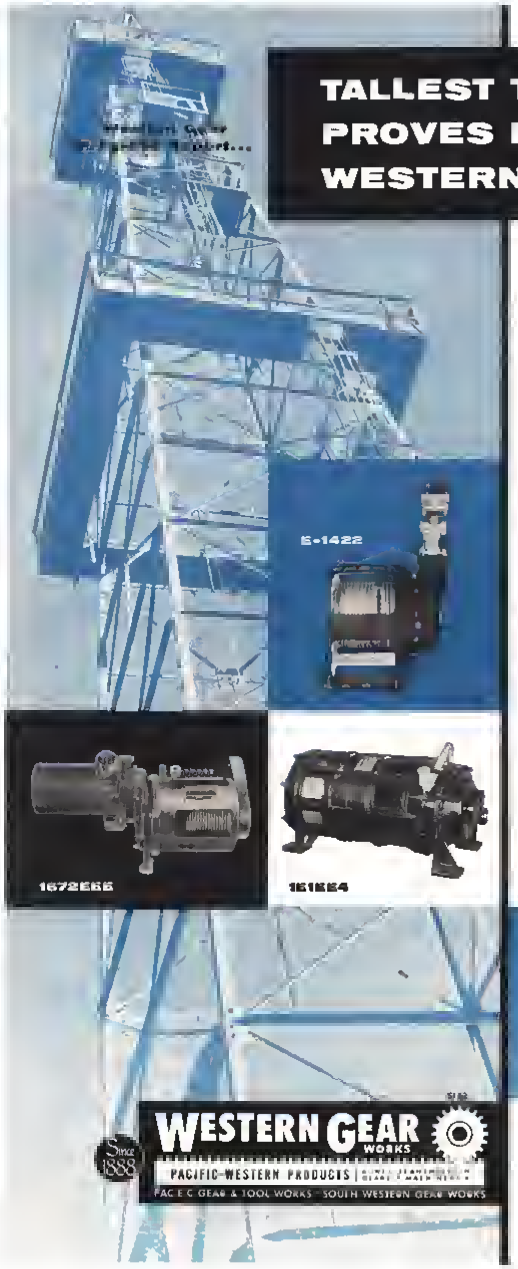
Canada: Dow Corning Silicones Ltd., Toronto; England: Midland Silicones Ltd., London; France: St. Gobain, Paris

TALLEST TEST STAND PROVES RELIABILITY OF WESTERN GEAR HOISTS



One of the world's tallest aircraft hoist test stands, this 120' tower erected at the Lynwood plant of Western Gear Works provides exact duplication of the dynamic conditions experienced on a cable at full length and on hoist mechanisms when raising and lowering specified loads. It also enables Western Gear engineers to study the regenerative motor characteristics involved during lowering. Data thus obtained provides positive information on cable up to 120' in length, motive power and hoist mechanism itself.

It's another example of Western Gear thoroughness which characterizes all its products.

Western Gear has been designing and building hoists and other specialized aircraft equipment for transmitting motion or torque since the early days of mechanized flight. Why not take advantage of this experience and skill in solving your mechanical power transmission problems? No obligation! Address inquiries to Executive Offices, Western Gear Works, P.O. Box 182, Lynwood, California.

MODEL E-1422 CABLE DRUM: Spooling capacity, 20' of 1/4" cable. Maximum cable pull 6500 lbs. Unlimited travel. Speed 8 RPM. Powered by hydraulic motor. Direction, reversible.

MODEL 1612E4 HOIST: Has 50' of active cable drum capacity. 55' of 3/16" diameter cable. Operating load up to 1600 lbs. Capable of operating 30 FPM. Incorporates unique feature of paying cable off at a fixed point. Powered by a low pressure air motor with hand crank for emergency operation.

MODEL 1672E66 HOIST: Spools 150' of 3/16" cable, 800 lbs. operating load. 50 FPM average cable speed. Maximum lift of 1200 lbs. Ultimate static load 3,000 lbs. Cable level wind device furnished. Unit powered by 28 V. DC motor.

MODEL 1612E5 CAPSTAN: For use with rope. Has operating load of 1600 lbs. at rate of 30 feet per minute. Powered by low pressure air motor.

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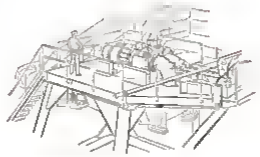
Since 1888
PACIFIC-WESTERN PRODUCTS
PACIFIC GEAR & TOOL WORKS · SOUTH WESTERN GEAR WORKS

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.)
SEATTLE AND HOUSTON—REPRESENTATIVES IN PRINCIPAL CITIES

NEW HYATT JET ENGINE BEARINGS PROMISE ADDED AVIATION SAFETY

. . . have performed perfectly for hours after oil supply was interrupted



Breaking "bearing barriers" is a habit with Hyatt, builder of more jet engine roller bearings than any other manufacturer—*but Hyatt engineers have really outdone themselves with this sensational new development!*

These "Safety Reserve" oil-impregnated, sintered bronze cage roller bearings, applied to the compressor and turbine shafts of jet engines, have *performed perfectly for hours after the oil supply was interrupted.* Here at last is the answer to the oil-system-failure problem—an answer that will soon be bringing planes and pilots safely home despite loss of lube. Remember, when you're faced with a formidable "bearing barrier," *come to Hyatt for help!*

THE SECRET of this extraordinary new bearing is the ability of its porous sintered bronze cage to retain many hours reserve supply of oil. Each tiny interstice acts as a lifesaving "oil well" which prevents bearing failure even when all outside lubrication has been interrupted for hours at the tremendously high rpm's and temperatures developed by jet engines.

HYATT ROLLER BEARINGS

STRAIGHT · BARREL · TAPER

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

"American Welded" Sinews in every B-52

America's long-range bomber, the B-52, is another plane that flies with American Welded components.

From titanium rings to aluminum oil tanks, today American Welding supplies the major U. S. aircraft engine manufacturers.

If your product requires welded components or you think welding may be the best method of fabrication — our Product Development Division will be glad to work with you. Write or call today.

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Phil-trol®

Data for Relay Users

New manufacturing methods and assembly techniques at Phillips Control give Phil-trol Relay users "custom" and "standard" relays at lower cost.

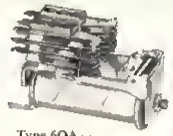
Coils in a wide assortment of winding types and characteristics are almost completely interchangeable during assembly, throughout most Phil-trol models. Varying marginal and timing values, various operating values, timing sequence and release constants are also applicable to almost every Phil-trol Relay, during regular production runs. The "custom" addition or omission of springs is accomplished just as easily. And variation of contact forms, or of contacts themselves, is standard practice at Phillips. This means that relays for special or complex control problems, which formerly required complete engineering from "Scratch," in many cases now can be produced much faster and at little or no increase in price over standard models.

You are invited, with no obligation, to have Phillips Engineers consider and recommend whether or not there is a Standard Phil-trol Relay which will precisely fulfill your specifications, at a substantial savings in cost.

PHIL-TROL MULTI-CONTACT RELAYS

Type 2QA—Direct Current
Outside dimensions
4 1/25" long x 1.5" wide
Height of stack depends on contact form

The PHIL-TROL Type 2QA Relay is highly sensitive, adaptable for marginal operation and provides fast closing and opening of a maximum number of circuits. Its long-coil construction permits the use of high resistance coils and it may be engineered to operate on as little as .002 amps. Delay in the opening and closing times may also be provided. Operating voltage up to 230 volts D.C. Single or Double wound.



Type 6QA—
Direct Current
Outside dimensions
2 9/16" long x 1 1/2" wide

PHIL-TROL Series 6 Relays have excellent performance characteristics due to the minimum air gap within the magnetic circuit. For its size it has a comparatively large coil winding area, making an efficient relay. Since all wiring and mounting is located at the heel end it is particularly well suited for use where several relays are required on a single panel, such as for annunciators or on switchboards.

PHIL-TROL POWER RELAYS

Type 27QA—
Direct Current
Available in 2 pole, 3 pole, 4 pole and 5 pole 10 and 20 ampere models.

The PHIL-TROL Type 27QA Relay is specially designed to withstand severe vibration where positive, reliable operation is required such as in Aircraft and Guided Missile applications. Its extremely high efficiency makes it ideal where the power input to the coil is limited, such as for operation in the plate circuit of electronic tubes.

The PHIL-TROL 27QA is small in size, light in weight yet exceptionally rugged. It provides high contact pressure and current-carrying capacity, with low power input. Its two-coil design is an important factor contributing to its efficiency. Magnetizing force losses at the armature hinge are completely eliminated. A greater number of ampere turns for a given resistance, and consequently an exceptional operating force are thus possible for a given power input.

Type 4BQA—
POWER
Direct Current
Outside dimensions 1 23/32" long x 1 3/16" wide

PHIL-TROL Series 4B Power Relays are miniature D.C. power contactors with high-current carrying contacts. These relays are small in size and light weight with the added feature of having the capacity to handle large currents. The large coil capacity permits high contact pressure and large contact-gap with minimum power consumption. Contact arms and shorting bar are of low-resistance phosphor-bronze. Solder terminals are large. Available with single or double wound coils. Operating voltage up to 200 volts D.C.

PHIL-TROL HERMETICALLY SEALED RELAYS

This PHIL-TROL Series 20366 *Sealed Relay* is available with two to fourteen terminal headers, has three mounting studs. It will accommodate the Type 4 Relay with a maximum of six springs on each pile-up.

This PHIL-TROL Series 4001S Sealed Relay accommodates a Type 4QA Phil-trol Relay with 4 springs per pile-up or a 4BQA Relay with a maximum of 3 springs per pile-up. Minimum size makes this unit most popular.

PHIL-TROL ACTUATORS

SOLID FRAME TYPE
Type 41 Phil-trol Actuator

PHIL-TROL Actuators are designed to meet all industrial, commercial and domestic requirements for small, compact, solid-frame solenoids to develop unusual power. Pull tests show that Phil-trol Actuators develop considerably more power than ordinary solenoids of the solid-frame type. This increased power is the result of exclusive Phil-trol design and superior qualities of construction. Five models of varied sizes and capacities are available for operation in usual commercial A.C. and D.C. voltages.

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Help Solve Your
Relay Problems

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Gentlemen: Please send me your General Catalog ☐
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Phil-trol Hermetically Sealed Relays ☐ Phil-trol Actuators ☐

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LORD DYNAFOCAL MOUNTING

MR-36M

FOR R-2800C ENGINES

LORD FACTS ABOUT VIBRATION

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To Operators of Convair 240's and 340's, Douglas DC6 Series, Martin 404's, and Military Aircraft using R-2800C engines –

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PROVEN DURABILITY—The MR-36M has proved its durability in extensive service on commercial and military airliners, thus reducing maintenance and operating costs.

LIGHTER WEIGHT—The MR-36M is the lightest available production mounting for R-2800C engines. It provides a weight saving of nine pounds per engine over our previous light weight design.

GREATER STRENGTH—Design and construction features of the MR-36M provide greater strength than any previous designs for this mounting.

INTERCHANGEABILITY—The MR-36M is completely interchangeable without rework on aircraft using R-2800C engines. It provides all physical dimensions and vibration characteristics of heavier mountings now in use.

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Flying a modern jet with its mighty power, lightning speed and high maneuverability is no job for a layman! Such precision flying requires a skilled hand and hundreds of hours of experience. But the skill and experience go deeper! Today's jet aircraft require precision parts—like bearings—to stand tremendous speeds and high temperatures. ☆ Bower aircraft bearings—first choice of leading jet engine manufacturers—are built to stand turbine speeds as high as 15,000 RPM and temperatures as high as 600° F. with a minimum of lubrication. Bower's many years' experience, matchless skill and consistent emphasis on quality give the aircraft industry bearings held to tolerances measured in millionths of an inch. ☆ An experienced Bower engineer will be glad to show you how Bower bearings can improve your product's performance. Get in touch with Bower soon.

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With large, widely-diversified manufacturing facilities and an impressive engineering background at its command, Barber Colman Company integrates the know-how of these various highly specialized fields of interest into the design of every aircraft product

For example, all electro-mechanical actuator parts (except for ball bearings, switches, and other standard hardware) are made, assembled, and tested at Barber-Colman Company.

As a manufacturer of machine tools for industry, the company utilizes Barber-Colman hobbing machines and precision hobs for production of the actuator gears and pinions

Having twenty-five years of motor manufacturing experience, Barber-Colman Company is well equipped to produce the many modifications and special features required for motors in aircraft and missile applications

Molding dies and the plastic parts they produce are manufactured by the Barber-Colman Molded Products Division.

Well equipped chemical and metallurgical laboratories and trained personnel maintain continuous surveillance of raw materials and processes . . . an essential part of an adequate system of quality control

In all, whether your project calls for actuators or any of the many other aircraft products made by Barber-Colman, you can be sure that here it is in responsible hands . . . with rigid control *at every step* from engineering, through manufacturing, to application!

BARBER-COLMAN KYLC ACTUATOR

BARBER-COLMAN PLASTICS MOLDING
Loading a mold. This division makes plastic brush caps and rear end caps for motors and terminal and rheostat blocks for actuators.

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Winding the armature of a sub fractional hp motor. Barber-Colman Small Motors Department is equipped to manufacture both permanent magnet and split series motors

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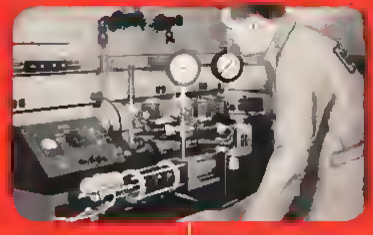
Actuator pinion being precision hobbed on Barber-Colman Hobbing Machine. Gears and pinions are assembled and inspected by highly skilled specialists.

BARBER-COLMAN TESTING FACILITIES
Dynamic testing of an actuator. Facilities include a complete laboratory for simulating flight conditions and extensive equipment to ensure that all products meet performance and environmental requirements.



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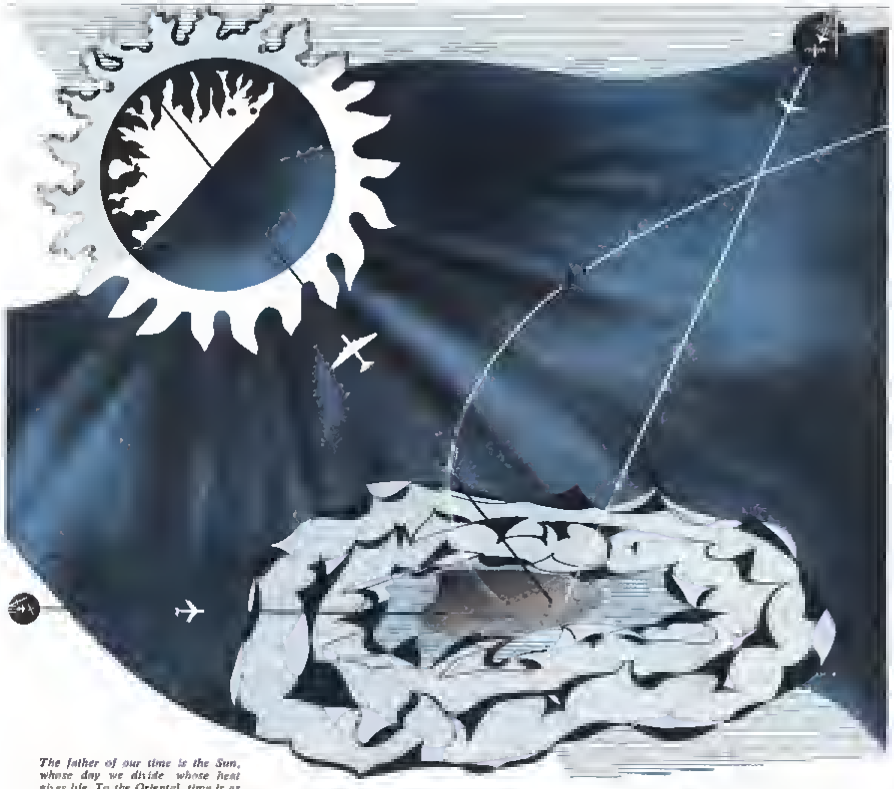

The father of our time is the Sun, whose day we divide whose heat gives life To the Oriental time is as a silent pool and man comes and goes as do the ripples on its surface—enduring within the great continuum of creation To the Westerner, time is an arrow, swift in flight—sure in destination, passing, ever passing on.

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Flights come and flights go. The sun boils and pools freeze. Time comes and time goes, but the accuracy of Kollsman products endures.

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Leave it to AC to find a way to combine metal and glass to lick one of the biggest problems in aircraft spark plug design.

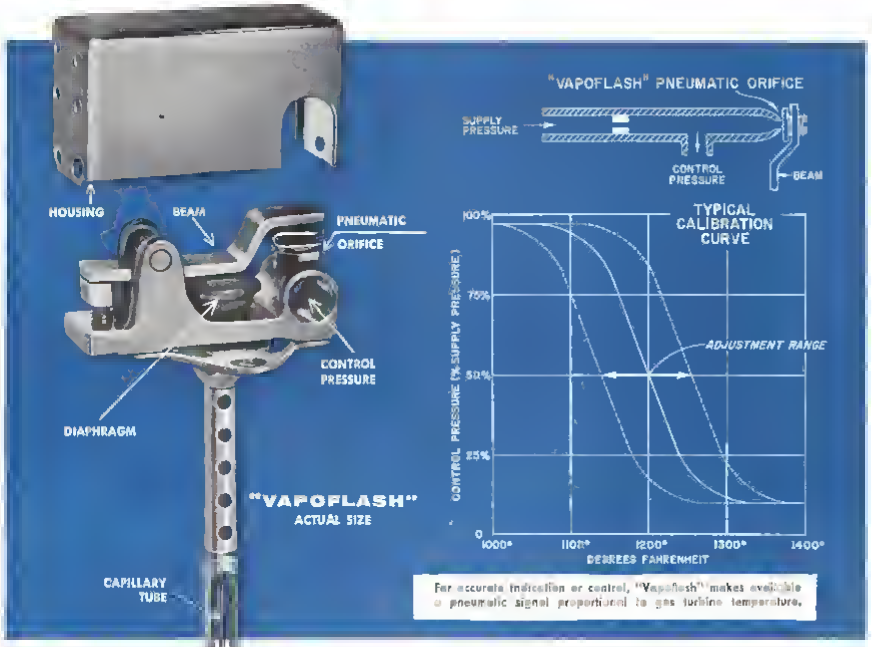
For years planes operating at high altitudes were plagued by the effects of poorly sealed center electrodes. Then, AC engineers found a way to use copper and glass to replace the center section of spark plug center electrodes with a conducting seal.

This material—found *only* in AC Spark Plugs—stands up under use far better than any other material of similar nature.

Plugs last longer . . . planes fly higher . . . operating costs are lower because AC engineers developed the copper glass seal.

This is one more reason why AC Spark Plugs in regular commercial airliners have lasted two to three times the normal life of ordinary spark plugs under identical operating conditions.

AC SPARK PLUG DIVISION • GENERAL MOTORS CORPORATION FLINT, MICHIGAN



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. . . an entirely new development in gas turbine control components

"Vapoflash" — a unique new measuring probe — provides the advantage of high-gain, pneumatic output. The power level of the control signal is such that greatly simplified mechanisms can be applied to modulate main engine and afterburner fuel flow, and the exhaust nozzle area of turbojet engines.

The accurately calibrated "Vapoflash" probe exposes a mercury-filled capillary tube to the gas stream of the jet engine. As the gas temperature rises to the control set point, the pressure of the vaporized mercury in the element develops a signal which is measured by a metal diaphragm. As the diaphragm moves, it actuates a preloaded cantilever beam which operates a pneumatic orifice. Compressor discharge pressure serves as supply pressure. adequate power is conveniently available for control actuation. With several "Vapoflash" units connected in parallel for averaging, reliable measurement and control of gas turbine temperatures is simplified.

We are confident that our long experience in developing, manufacturing and testing jet engine control components can be of practical service to you. Our engineering department will welcome the opportunity to analyze your control requirements.

MANNING, MAXWELL & MOORE, INC.

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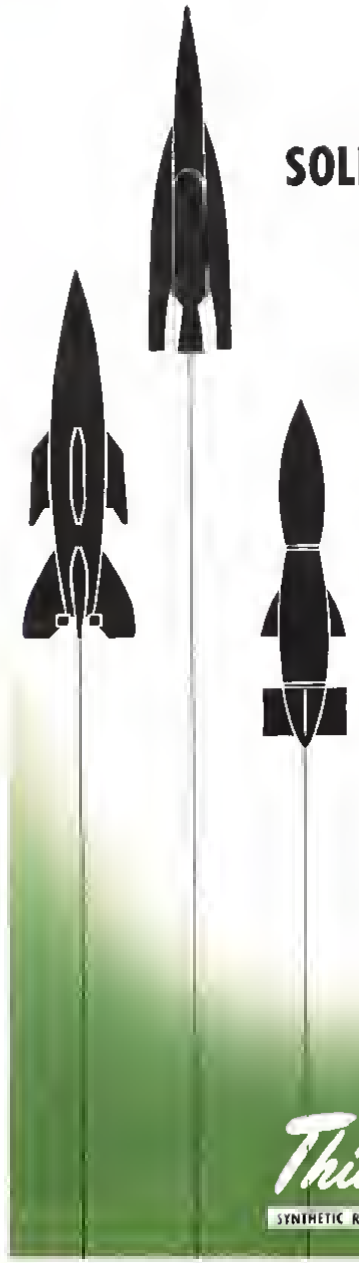
OUR AIRCRAFT PRODUCTS INCLUDE TURBOJET ENGINE TEMPERATURE CONTROL AMPLIFIERS • ELECTRONIC AMPLIFIERS PRESSURE SWITCHES FOR ROCKETS, JET ENGINE AND AIRFRAME APPLICATIONS • PRESSURE GAUGES THERMOCOUPLES • HYDRAULIC VALVES • JET ENGINE AFTERBURNER CONTROL SYSTEMS.



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Thiokol's development program in rockets and solid fuels has proven the feasibility of solid-propellant thrust motors of virtually unlimited size.

These developments are the result of coordinated chemical research, design, fabrication, developmental testing and manufacture conducted by Thiokol's rocket development and manufacturing team.

Practical solid propellant rockets and boosters developed by Thiokol range in size from some of the smallest to the largest solid-propellant units known. They meet severe performance and ballistic requirements - many of which were considered impossible to attain until now.

Solid Propellant Propulsion and Power Units for:

All Types of Rockets — Gas Generators
Guided Missiles — Aircraft Assist Take-Off Units
Boosters — Short Duration Power Plants

Thiokol projects include participation in development programs on Douglas "Honest John" and Armour Research Foundation "T-131"

ENGINEERS AND CHEMISTS Explore a career as a member of Thiokol's development and manufacturing team! We welcome inquiries from mechanical engineers, chemical engineers and chemists interested in the rocket field.

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Longhorn Division, Marshall, Texas
Elkton Division, Elkton, Maryland

Thiokol Chemical Corporation

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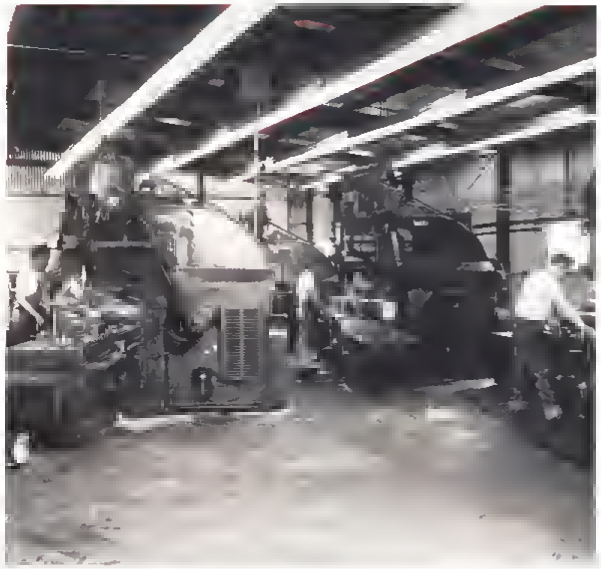
• Loud meets the increased aircraft demands for quality and economy with expanded facilities and equipment.



ONE OF THE LARGEST milling departments in the West contains forty large mills, over 10 of which are of the Hydrotel automatic duplicating type

▸ **History**—From a small repair shop started in 1908 Loud has grown into one of the most completely equipped job machine shops in Southern California. This modern plant, including engineering and test laboratories, occupies almost two hundred thousand square feet and employs approximately seven hundred persons.

▸ **Facilities**—Within this modern completely equipped plant fabrication of the smallest precision valves to the largest aircraft structural fitting is accomplished. Loud is one of the very few plants equipped to handle all phases of manufacture from raw material to finished product in one plant. One of the largest milling departments in the West contains forty large mills, over 10 of which are of the Hydrotel automatic duplicating type. Other unusual equipment includes flash welders—one an 800 KVA giant capable of up to 12 square inches of chrome moly up to 10 inches in diameter; complete heat treating facilities including a 10 foot deep vertical atmospheric controlled furnace (necessary for the production of highly stressed arresting hooks), automatic duplicating lathes, automatic chucking lathes, qualified spot welding machines, complete qualified plating facilities including hard chrome, anodizing, cadmium, silver, copper, and dichromate (for magnesium), all types of grinding and honing machines, and the finest of inspection tools such as comparators and surface analyzers.

In addition to this unusual equipment the plant contains a multitude of turret lathes, hand screw machines, automatic screw machines, engine lathes, drill presses—some automatic indexing, large radial drills, boring machines, shapers, and planers. Complete qualified facilities for arc, oxy-acetylene, and heli-arc welding of steel and aluminum are provided.

These facilities make Loud an outstanding source for major sub-assemblies of aircraft.

With this complete manufacturing facility in one plant Loud can produce major structural sub-assemblies. An assembly line for the production of tactical ground handling equipment is currently turning out jet engine cradles in large quantities.

▸ **Products**—Loud produces complicated structural fittings of both steel and dural, all types of machined parts—large and small, hydraulic cylinders, valves, hand pumps, servo-control mechanisms, pressure tanks, landing gear struts, nose wheel steering units, pneumatic and fuel valves and filters, all to exacting aircraft specifications.

▸ **Progressive**—Loud's modern manufacturing facilities are constantly being expanded to meet the increased aircraft demands for quality and economy. This has resulted in the ability to produce precision machined products of the highest quality at a lower price than can be produced by the customers themselves.

"The tough jobs go to Loud" is indicative of the respect manufacturers have for Loud 'know how.'

- **Engineering and design development by Haskel Engineering Associates, Glendale, California**
- **National Sales and Service by Haskel-Loud Aircraft Service Corp., Glendale, California**
- **Resident Sales Engineers located in Seattle, Wash., Kansas City (Independence), Mo.; Baltimore, Md.**

H. W. LOUD MACHINE WORKS, INC.
969 E. 2nd Street Dept. 10 Pomona, California

AVIATION WEEK

Volume 62
No. 11
March 14, 1955

TWENTY-SECOND ANNUAL INVENTORY OF AIRPOWER

AIRPOWER IN THE AGE OF PERIL

The 22nd annual inventory issue is devoted to the role of airpower in what President Eisenhower has termed the "Age of Peril." It is a report interpreting the significance of airpower in the key countries of the world.

This issue was compiled by the Aviation Week staff, each reporting on the field in which he specializes and augmented by the global facilities of the McGraw-Hill World News organization.

It was prepared with the cooperation of aircraft industry and government sources throughout the world and is intended to serve as a standard reference on aviation progress during the past year and a guide to the trends of 1955.

AVIATION WEEK

A McGRAW-HILL PUBLICATION

• AIRPOWER FORECAST

Aviation to Stabilize Near Peak

Stability will mark the aviation market in 1955. Sales of airframe, engine, avonics and guided missile manufacturers will continue at a level only slightly below the all-time peak of 1954. Profits for 1955 will be very close to the level of 1954 that saw most major airframe firms earn net incomes surpassing their highest World War II profits.

Trunk airlines will boost gross revenues as they capture a larger share of the growing American and international travel market from surface carriers. But the airlines face grave management, eqnipment and regulatory problems that can narrow their profit margins. U.S. flag carriers face increasing competition from subsidized foreign airlines.

Prospects for the local-service airlines appear to be brightening, due to improved management and strong congressional support for permanent certification. Outlook for cargo airlines is also better, after a dim year in 1954, due to increasing military demand for an aerial logistics system and better equipment.

HELICOPTER PROSPECTS STABLE

HELICOPTER INDUSTRY will reflect the general stability trend, continuing at 1954 levels in both military and commercial sales and operations. Business flying is still expanding steadily. Manufacturers of smaller civil transports will find a slowly expanding market for their products in the business and agricultural market.

The longrange defense program adopted by the Eisenhower Administration in 1954 is still the key to the future of aviation. Concept of the "Age of Peril," requiring sustained effort to maintain strong military forces in being rather than frantic mobilization to meet a specific instant of crisis, has introduced an element of stability to the aircraft industry that has been lacking since its founding 50 years ago.

It is now possible to predict at least three more years of prosperous stability for the aircraft industry—barring the ever-present possibility of devastating nuclear war. This prediction rests on federal funds already appropriated or requested for aircraft, avionic and missile procurement. At the end of 1954, the Defense Department had $28 billion in appropriated but unexpended funds earmarked for purchase of aviation hardware. In addition $7.8 billion was requested in the fiscal 1956 budget for aircraft, missiles and avionics, plus $1.4 billion for research and development of which 80% is devoted to aviation and its related problems.

$9-BILLION SPENDING LEVEL

DURING FISCAL YEAR 1955 which ends next June the Defense Department will have poured close to $9 billion into the industry producing aviation products plus nearly another billion for research and development. Spending on aviation products for the fiscal year 1956, beginning next July, is programmed at about the same level. Breakdown of this procurement program indicates about $7.5 billion annually for aircraft and related equipment, $700 million for guided missiles, and $700 million for ground-based electronics not included in airframe or missile packages.

Trend in the airframe industry will show a fairly constant output of airframe pounds—about 150 million annually—but a gradual decrease in the number of aircraft produced. This is because heavier and more expensive bombers and transports are rolling off the production lines while fighter and trainer deliveries are dropping. Avionics will get a larger share of the military airpower dollar in the future. The fast-growing missile industry now serving USAF, Army, and Navy will push past the billion-dollar mark in fiscal year 1957 and is destined for major growth during the next decade.

TECHNOLOGICAL RACE

DOMINANT FEATURE of the industry manufacturing for military airpower during the next decade will be the fierce technological race being run between the United States and Russia. The pace of research and development will be the key to national success as well as the barometer of future business for individual firms in the aircraft, avionics and missile fields. The major business of the future will go to firms successfully developing equipment incorporating large performance improvements within the time span allotted the military services to stay significantly ahead of their Russian competitors.

Among the major areas where successful research and development effort will be the future key to superior military equipment and business success are:

- **Supersonic Flight.** The stability and control problems of this frontier have been only sparsely explored by research aircraft. Much fundamental research and development remains to be done in this field before fleets of fighters and bombers can operate and perform their missions at supersonic speeds.
- **Air Defense System.** The avionic, aircraft, armament and organizational problems in this vital field have barely been scratched.
- **Nuclear Power.** The use of nuclear power to propel aircraft has already been determined to be feasible for military operations. Time money and engineering skill are the factors in the formula that will successfully translate scientific proof into operational capability.
- **Air Logistics System.** This requires not only fundamental new developments in aircraft and powerplants but also in electronic business methods, new cargo-handling and packaging equipment and maintenance techniques.
- **Intercontinental Ballistics Missiles.** This is a vast new field opening, with tremendous technical obstacles to surmount. It will get major attention from the Defense Department.

There are many areas of conflict developing between Defense Department policy and traditional American business methods in handling the research, development and production of new military weapons systems. These conflicts will pose serious problems both for industry management and military leadership.

> "We live in an age of peril. We must think and plan and provide so as to live through this age in freedom—in ways that do not undermine our freedom even as we strive to defend it. Our defense must be carefully planned and steadfastly sustained. . . ."
>
> "The military budget emphasizes modern airpower in the Air Force, Navy and Marine Corps and increases the emphasis on new weapons, especially those of rapid and destructive striking power. It assures maintenance of effective retaliatory striking power as the principal deterrent to overt aggression. It accelerates the continental defense program and the build-up of ready military reserve forces. . . ."
>
> "It is essential that we together with other nations of the free world maintain a level of military strength which will effectively discourage any would-be aggressor from attacking. We cannot accept less. . . ."
>
> —President Dwight D. Eisenhower

The domestic and international airline system of this country is becoming an increasingly important element in military and civil defense planning.

The civil air transport fleet is an important element in the aerial logistics system that will be necessary to support combat operations of military airpower in a major nuclear war or in the fringe wars that have become a feature of Communist tactics. In the event of atomic-hydrogen bomb attacks on the North American continent, air transport offers a more flexible and less vulnerable transport system to meet both civil and military requirements in a national disaster than does any form of surface transport.

AIRLINE RATE PROBLEM

THE AIRLINES ARE STILL TIED to a prewar rate structure but are faced with a dilemma that now divides the industry's management and regulatory authorities on the wisdom of raising it. For the big inroads made by air transport in the travel market have come only when its stabilized fares became competitive with the rising fares on surface carriers. Whether an increase in airline fares will reduce traffic significantly is a question that will loom large in 1955.

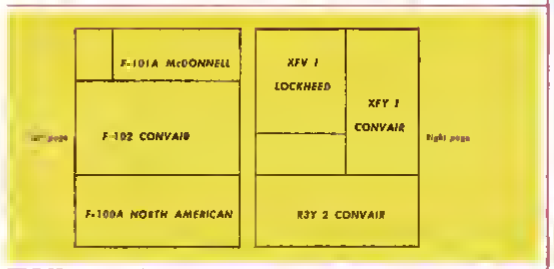
A major reequipment conversion to gas-turbine-powered transports is another major airline problem that will move closer toward solution this year.

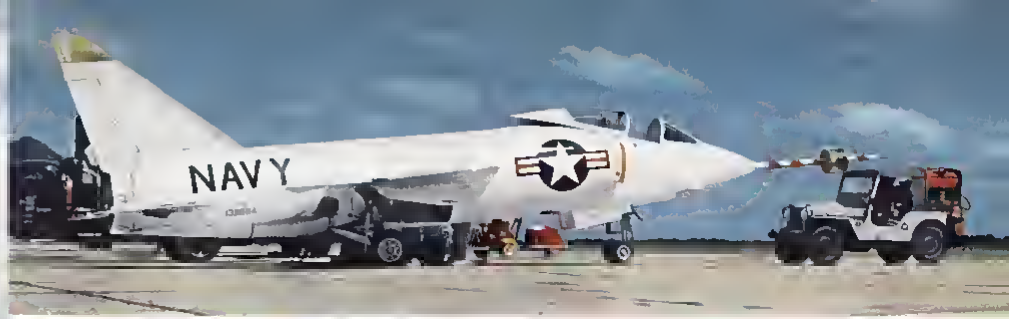
Major airline decisions on jet equipment will come shortly after USAF announces its awards for a jet tanker that can be used for a prototype and production tooling for commercial jets. Big problem for the Eisenhower Administration in the airline picture will be to reconcile its opposing requirements for cutting airline subsidy and insuring a strong domestic and international air transport network to support its defense policies.

ROBERT HOTZ

Aviation Week
Color Portfolio

22nd INVENTORY OF AIR POWER





F9F-9 GRUMMAN

A3D-1 DOUGLAS

CONVAIR TERRIER

707 BOEING

F 89D
NORTHROP

B 57B GLENN L MARTIN

● MILITARY AVIATION

Nuclear weapon systems brought on the Age of Peril. To defend against their immense power and to exploit their full offensive force if need be, the Air Force, Navy and Army are revolutionizing their combat formations.

Airpower dominates the revised doctrines. The Air Force has begun to explore entirely new technological frontiers of aviation. Aircraft and missiles are taking over a near-monopoly of the Navy's military punch. The Army expects vast expansion of airlift to give it far-ranging mobility, and guided missiles and rockets to expand its firepower.

TAKEOFF AT THULE: CONVAIR B-36

Aircraft Buildup Nearly Complete . . .

USAF's Next Goal Is Superior Weapons

By Robert Hotz

U. S. Air Force has grown to significant strength with 121 wings equipped with modern aircraft and combat-ready in March.

Now it faces grave problems in strategy, tactics, logistics, command organization and technology to maintain an effective lead over its Russian competition and to fulfill successfully its mission as a major instrument of U. S. foreign policy in deterring Soviet aggression

The numerical growth of USAF is nearing completion. The current strength of 121 wings contrasts with the 42 wings active in 1949, the last pre-Korean war. During the next two years 16 wings will be added to reach the currently authorized level of 137 wings manned by 975,000 officers and men. USAF has also completed a major qualitative advance with all of its current combat units equipped with jet-powered aircraft except for the venerable Convair B-36 with composite piston and jet power that is still the backbone of USAF's long range atomic striking force.

▶Soviet Advances—USAF faces its most significant problem in the technological challenge of Soviet airpower. President Eisenhower, Gen. Nathan F. Twining, USAF Chief of Staff, and Roger Lewis, USAF Assistant Secretary for Materiel, have all warned recently of the growing threat of Russian technical achievements in airpower and atomic weapons. They have all indicated the present margin of U. S. superiority may be reduced to parity with Russia in the next few years.

A growing clamor of claims to Russian superiority in atomic and hydrogen weapons from high level propagandists in Moscow indicates the Soviets have reason to believe they may soon draw abreast of the U. S. in the atomic-airpower equation.

Official Russian sources have been less vociferous on their delivery capability for their atomic and hydrogen weapons. The appearance over Red Square in Moscow last May of a giant sweptwing subsonic bomber powered by four extremely large turbojets and unofficial reports seeping through the iron curtain on intensive activity on long range missile development indicate the Russians are engaged in a major effort to improve their delivery capability.

▶New Problems—Never in the history of American airpower has research and development assumed such critical importance. USAF has been spending just over $400 million annually on this vital effort but will increase research and development spending to $540 million in fiscal 1956 and ask for $570 million in new funds. However, there are serious doubts among many of the key people now working on the frontier of flight whether this scale of effort will be adequate to meet the unprecedented development problems posed by effective nuclear delivery systems and a modern air defense system effective against future weapons of aerial attack.

In addition, many of the basic research and development facilities required, such as the long-range missile test range, the Arnold Air Engineering Development Center, the Unitary Plan windtunnels and nuclear powerplant laboratories, are still unfinished and only partially usable. Shortage of trained engineering and scientific personnel to man USAF research and development facilities and other organizations supporting military aeronautical research is an increasingly acute problem with no effective solution in sight.

Development Plans

A growing question mark is looming over the effectiveness of the USAF development cycle procedure utilizing the design competition in industry in stimulating new weapon systems. The number of recent weapons systems that have sprung from industry initiative in developing a prototype and selling it to fit a USAF requirement far exceeds those originating from a USAF design competition.

Several recent USAF design competitions have proved barren of any business for the industry after considerable expense. There is now strong feeling that a fast-moving industrial management backed by competent technical teams can move swifter than the ponderous USAF development system that now stretches a web of red tape from Pentagon through many commands.

Some of the outstanding examples of equipment developed from individual company initiative and sold outside the weapon system concept are the Lockheed F-94C night-fighter and TV-2 trainer, the North American F-100 Super Sabre, the Pratt & Whitney J57 turbojet; the Martin B-57 light

PREFLIGHT AT THULE: CONVAIR B-36

NORTH AMERICAN F-86D SABRES

BOEING B-52A STRATOFORTRESS

USAF Planes on Hand

As of Jan 1 in the year below	Type				Totals
	Combat	Transport	Trainer	Communications	
1942	4 477	254	7,340	226	12 297
1943	11 607	1 857	17 044	2,785	33 304
1944	27 448	6 465	26 051	4 267	64 232
1945	41 051	10 456	17 060	3 240	72 726
1946	25 077	7 500	7 611	9 546	34 782
1947	17 288	4 868	6 907	2 014	30,005
1948	12 118	3 931	5 714	1 446	23,814
1949	9 031	3 712	6 177	1 148	20,068
1950	8 004	2,930	5,811	388	17,222
1951	8 159	2 960	5 961	358	17 332
1952	—	—	—	—	20,000*
1953	—	—	—	—	20,500**
1954	—	—	—	—	21,700***
1955	—	—	—	—	22,400

* Includes 16,000 in active inventory and 4,000 inactive.
** Includes 16,000 active and 4 000 inactive
*** Includes 17 700 active and 4,000 inactive
SOURCE USAF

bomber, the Douglas B-66 light bomber, the Lockheed F-104 supersonic fighter, and the Boeing KC-135 jet tanker plane

▶ **Controversy**—USAF faces a major task in successfully compressing its equipment development cycle to get new weapon systems from the drawing board to combat units in less time than the Russian competitors The weapon system development concept is now pretty generally accepted by the industries serving USAF but its implementation and administration is still a source of controversy both within USAF and in the various segments of industry

Wisdom of the Cook-Craigie Plan of slow production during early development phase of new aircraft has been proved by the experience of the F-100, F-102 and the B 66. All of these aircraft have encountered stability and control problems in the transonic speed range during their early production phase. Modifications can now be cranked into the production lines while output is still low, leaving the bulk of volume production until the aircraft have throughly proved their operational reliability This modification before large scale production is begun and while the inventory is relatively low (only one squadron of F-100s was operational and the B 66 and F-102 are not yet in squadron service) contrasts with earlier USAF experience that found thousands of a single aircraft type grounded for long periods while modifications were retroactively fitted

USAF Aircraft Types on Order

COMPANY	PLANE	NAME	COMPANY	PLANE	NAME
Beech	T-34A	Master	Lockheed	F-104A	
				C-121C	
Boeing	B-47E	Stratojet		RC-121D	Constellation
	RB-47E	None		YC-121F	
	B-52B	Stratofortress		C-130A	
	B-52C	Stratofortress		T-33A	Shooting Star
	B-52D	Stratofortress			
	KC-97G	Strato Freighter	Martin	B-57B	Canberra
	KC-135A			B-57C	Canberra
Cessna	T-37A				
			McDonnell	F-101A	Voodoo
Convair	F-102A	None			
	C-131B	Samaritan	North American	F-86D	Sabre
	C-131D	Samaritan		F-86H	Sabre
	T-29C			F-100A	Super Sabre
	T-29D				
Douglas	B-66B		Northrop	F-89D	Scorpion
	RB-66B				
	RB-66C		Piasecki	H-21B	Workhorse
	C-118A	Liftmaster		YH-16	Transporter
	C-124B	Globemaster 2		YH-16A	Transporter
	C-124C	Globemaster 2			
Fairchild	C-119G	Packet	Republic	F-84F	Thunderstreak
	C-123B	Avitruc		RF-84F	Thunderflash

USAF Budget

For the second consecutive year under the Eisenhower Administration USAF received the lion's share of the fiscal 1956 defense budget. USAF is scheduled to get $15.5 billion out of a $32 billion total—just about twice the funds allocated the Army and Navy However, the fiscal 1956 USAF budget is essentially a maintenance and modernization budget for the 137-wing program since all funds for the buildup to that level have been appropriated in prior years.

▶ **New Requirements**—While this budget appears to be adequate for maintaining the strength of 137 combat wings with the most modern possible aircraft types, it does not appear to provide for any substantial progress on the many new tasks USAF faces in the immediate future such as

- **Development** of an aerial logistics system.
- **Major improvement** of the continental air defense system
- **Construction** of a new air base complex tailored for supersonic aircraft and atomic warfare
- **Development** of tactical air units to effectively operate in fringe wars
- **Major improvement** of long range delivery systems for nuclear and hydrogen weapons

The revolutionary force of new developments in aviation and nuclear weapons is already upsetting the traditional concepts of USAF command organization even before this service celebrates its eighth birthday Initial example of a new type command in the atomic airpower Age of Peril is the Continental Defense Command headed by Gen Benjamin W Chidlaw, also commander of USAF's Air Defense Command. Gen. Chidlaw's new command includes not only USAF air defense wings but also Navy and Marine fighter squadrons assigned within the continental U. S , Navy radar picket vessels and aircraft and Army guided missile units Since the wide variety of nuclear weapons developed by the Atomic Energy Commission gives virtually any modern combat aircraft an atomic capability there has been discussion on concentration of all USAF and Navy aircraft equipped to deliver atomic or hydrogen bombs under a single command so that any execution of the "massive retaliation" policy would have the full weight of all our atomic airpower behind it rather than being delivered in bits as various commands were thrown into the effort

LOCKHEED RC-121C

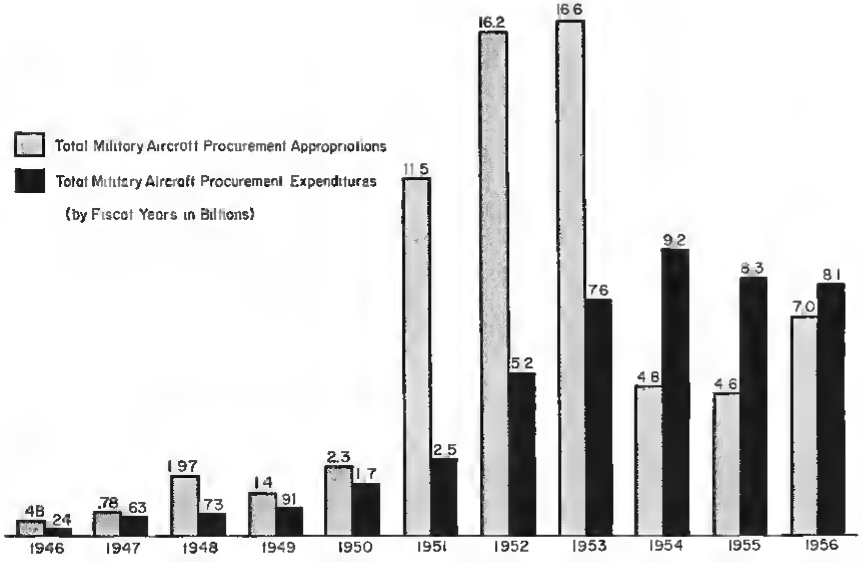
Airlift Debate

Use of airlift to provide the Army with the mobility it needs to fight effectively on a global front with limited manpower resources and to fight effectively in areas where atomic weapons are being used poses another major command and organizational problem. Should the Army develop its own airlift tailored to its specific need and under its own command or should USAF continue to do that job as a by-product of its other higher priority missions? Lieut Gen Frank Everest, USAF Deputy Chief of Staff for Operations, recently stated publicly that USAF could not now completely airlift a single Army division It is not likely that the Army will remain satisfied with this limited airlift capability and a major debate is developing on this

Major USAF Commands

Air Defense Command Ent AFB, Colorado	**Tactical Air Command** Langley AFB, Virginia
Air Materiel Command Wright-Patterson AFB, Ohio	**Military Air Transport Service** Andrews AFB, Md
Air Proving Ground Command Eglin AFB Florida	**Alaskan Air Command** Elmendorf AFB
Air University Maxwell AFB, Alabama	**Caribbean Air Command** Albrook AFB, C Z
Air Training Command Scott AFB, Illinois	**Far East Air Force** Tokyo
Air Research and Development Command Baltimore, Md	**Pacific Air Force** Hickam AFB, Honolulu
Headquarters Command Bolling AFB, Washington, D C	**Northeast Air Command** Pepperrell AFB, N F
Continental Air Command Mitchel AFB, New York	**USAF Europe** Wiesbaden Germany
Strategic Air Command Offutt AFB, Nebraska	**USAF Security Service** Kelly AFB Texas

CONVAIR RB-36

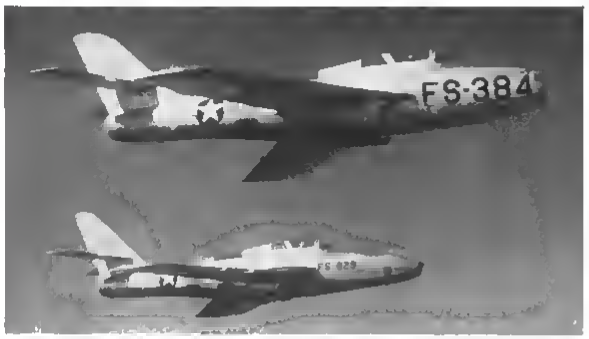


subject both in the Pentagon and on Capitol Hill.

Another major problem that has arisen in the post-Korean era is the requirement that USAF must maintain a large portion of its forces in a state of instant combat readiness—able to fight at a few hours' notice. This new factor means new techniques must be developed in production, maintenance and supply.

Strategic Air Command

Strategic Air Command is still the top priority USAF organization and now has the highest degree of combat-readiness of any USAF command. SAC, under the leadership of Gen. Curtis Emerson LeMay, is operating on a war-time basis. One example of how SAC maintains this constant combat readiness is the maintenance and modernization cycle organized to keep its B-36 and B-47 bombers in top shape. These bombers are funneled through the program at Convair-Ft. Worth, Douglas Tulsa and Lockheed-Marietta at a carefully scheduled rate that keeps only a tiny fraction of SAC's combat strength out of action at any specific time.



REPUBLIC F-84F AND RF-84F

►**Bomber Force**—SAC has pretty well phased in the Boeing B-47, also being built by Douglas and Lockheed, into its medium bomber groups as a replacement for the piston powered B-29 and B-50. There are still a few B-50 wings active, mostly for long-range weather reconnaissance. B-47 wings have been operated on training missions at SAC's far flung network of staging bases in North Africa, the Pacific and England, utilizing aerial refueling techniques. One B-47 caught in bad weather between England and Africa flew for 47 hr., 35 min. with the help of aerial refueling before landing.

The B-36, still being improved by a variety of top-secret devices, continues to be the backbone of the long-range atomic striking force. It is touch-and-go as to whether the latest improved performance B-36s could penetrate the Russian combination of missile and MiG defenses but with the addition of air-to-surface missiles in the near future and the use of the Ficon system for carrying a parasite jet fighter, the B-36 could remain an extremely effective long-range delivery system that would operate outside the short-legged Russian defensive missiles and fighters.

►**Tanker Need**—The first SAC wing is scheduled to get Boeing B-52 bombers this spring but this eight-jet bomber will not get into any appreciable unit service until the middle of 1956. Early B-52 wings will be equipped with reconnaissance versions. Bomber versions will be a longer and heavier B-52 model aimed at providing more built-in range and hydrogen bomb carrying capability. Full combat capability of the B-52 wings will have to wait on the arrival of the KC-135 jet tanker to refuel the bombers at speeds up to 550 mph. and altitudes up to 40,000 ft. where the jets operate more efficiently. B-52s tied to the KC-97 refueling pace of 25,000 ft. and 300 mph. would sacrifice significant range to make contact at that speed and altitude.

It would appear that SAC will be operating subsonic bombers until 1960 unless the present pace of supersonic bomber development is greatly accelerated. Convair is developing the B-58 supersonic delta-wing Hustler at its Ft. Worth plant but its progress has been hampered continually by opposition from the top leaders of SAC who are not sold on the feasibility of operating a supersonic bomber.

SKY SHAPES· LOCKHEED RC-121C AND F-94C, NORTHROP F-89 AND NAA F-86D

Tactical Air Command

The development of small atomic weapons that can be carried by fighter aircraft has given TAC a new importance in the USAF picture. TAC leaders are currently developing the concept of a highly mobile force of atomic bomb carrying fighters supported by turboprop-powered transports and aerial tankers for use as an international "fire brigade" to squelch fringe wars of Communist aggression while they are still in their early stages. With the advantage of hindsight it is evident now that by action of atomic bomb carrying fighters using weapons of localized effect the Communists' war effort in Korea could have been paralyzed and collapsed in a matter of days. The Chinese aggression into Indo-China could have been extinguished in a similar fashion if political considerations could have unleashed TAC. However it is apparent that a decision to employ these types of weapons in any future fringe wars has been reached and TAC will play a vital role in the future.

►**Aid to SAC**—The atomic capability of fighter aircraft combined with aerial refueling provides TAC with a tremendous capability to assist SAC in delivering its "massive retaliation." One fighter-bomber wing equipped with Republic F-84Fs and small atomic bombs is now stationed in England where it could reach many vital Russian targets.

In addition to the atom-bomb carrying F-84F, TAC is getting the Martin B-57 and Douglas B-66, both with atomic capabilities, and the Lockheed C-130 turboprop-powered transport that can double as a logistic support aircraft or an aerial tanker for its short-range TAC fighter flock.

Air Defense Command will have a hard row to hoe for the foreseeable future. Construction of the radar warning communications network essential to early detection of enemy aircraft is still under way. All-weather fighter aircraft now in service are largely short-range and shortsighted types although the Northrop F-89 is beginning to add a more efficient all-weather capability.

Not until missile carrying supersonic interceptors equipped with long range and reliable airborne radar and fire control systems begin to appear in sizeable quantities among ADC's fighter wings will the air defense of the North American continent assume any real danger to an enemy air force. Best guess is that the Convair F-102, armed with Hughes Aircraft fire control and Falcon missile, will become operational in 1956. USAF continues to invest in day fighters such as the North American F-100 and Lockheed F-104 despite the lessons of Korea that proved fighters needed radar sighting equipment even on the clearest days and the Navy's abandonment of the day fighter in its future procurement.

U. S. Plane Inventory

(End of fiscal 1955)

AIR FORCE	22,400
NAVY	13,000
ARMY	3,600

Force Levels

The following are the authorized air-power force levels under present military budget planning.

AIR FORCE	—137 combat wings.
NAVY	—17 carrier air groups plus support.
MARINES	—3 air wings
ARMY	—3,600 aircraft

Aerial Logistics

A combat force operating with nuclear weapons and sonic speed that is tied to surface supply line moving at the pace of a railroad train or freighter would sacrifice a large portion of its combat efficiency. Task of developing an aerial logistics system for the support of its global combat units at a pace geared to the tempo of modern air war rates a higher priority than USAF is currently giving it. The Lockheed C-130 turboprop medium range transport is well along in development and the Douglas C-133, its counterpart in the heavy transport class, should appear soon. Farther out in the dim development future is the Douglas C-132, with a 50-ton payload and a 500 mph. speed.

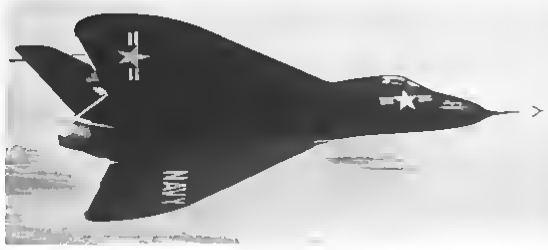
Originally planned as the aerial tanker for the B-58 supersonic bomber, the C-132 now appears destined to become the workhorse of the aerial logistics system. Boeing's KC-135, originally ordered as a tanker for the B-52 bomber, will also see service in a military transport role.

NORTH AMERICAN FJ-3 FURY

McDONNELL XF3H DEMON

● NAVY

Navy Recasts Tactics Around New Planes



DOUGLAS F4D SKYRAY

CONVAIR YF2Y-1 SEA DART

By Gordon Conley

U. S. Navy's investment in new airpower weapons and concepts is beginning to pay off with the most unusual and inventive aircraft design approaches developed by the military in recent years.

New prototypes, ranging from lightweight attack bombers and vertical-takeoff interceptors to fast flying boats, are the Navy's first healthy returns on its lean postwar budgets.

Still to come are several Mach 2 aircraft now on the boards plus a second new turbojet-powered seaplane, believed by informed observers to be a highspeed, longrange bomber.

The Navy and its amphibious partner, the U. S Marine Corps, are using these new airpower weapons to reshape their combat teams and tactics.

Air-sea combinations will make the sharpest break from concepts developed during World War II and Korea.

▶ **Task-Force Concept**—Task forces will be trimmed to a relative handful—probably three large carriers, seven all-guided-missile cruisers and two high-speed supply ships. But they will spread over an ocean area estimated at 33,000 square miles and be able to launch thermonuclear attacks against enemy bases within a radius of 1,500 miles or more.

Helicopters will replace destroyers in the task force, taking over anti-submarine, early-warning and rescue missions. In the future, copters also are expected to do the work of other small surface craft in the fleet, such as mine layers and mine sweepers.

Working with the carriers will be highspeed seaplane squadrons operating from mobile tenders within striking distance of enemy targets.

▶ **Nuclear Assault**—The Marine Corps will take supersonic fighters and lightweight bombers from Navy's new airpower arsenal to give nuclear punch to the vertical envelopment tactics developed during Korea.

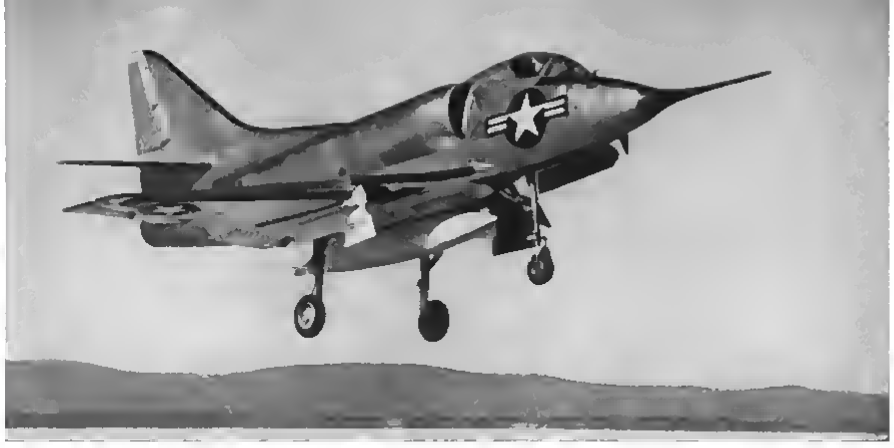
These aircraft will pound enemy beachhead positions with atomic bombs at the start of an amphibious assault. Troop-carrying helicopters will leapfrog the radioactive area. Supply and communications lines to the beach will be set up through washed down corridors.

Inventive Designs

The Navy is making its airpower comeback with new aircraft unsur-

CHANCE VOUGHT F7U-3 CUTLASS

DOUGLAS F3D SKYKNIGHT WITH SPERRY SPARROWS



DOUGLAS A4D SKYHAWK

passed in engineering ingenuity.

Some of these planes will begin operating with the fleet this year as Navy increases its carrier air groups from 16 to 17, phases out its last piston-engine airplanes and replaces them with turbo jet aircraft.

New planes still in the future include Chance Vought Aircraft's supersonic XF8U-1 fighter design and McDonnell Aircraft Corp.'s AH-1, an all-weather attack-fighter project.

▶**New Aircraft**—These are the outstanding prototypes or first production models delivered to Navy during the past 12 months:

• **Martin XP6M-1 SeaMaster,** first large U. S. turbojet seaplane. Designed primarily for mine laying and photo-reconnaissance, the SeaMaster also can carry out longrange bombing strikes or antisubmarine missions.

The sweptwing, T-tailed XP6M-1 is powered by four Allison J71 engines and will cruise at 40,000 feet at speeds exceeding 600 mph.

• **Douglas XA4D-1 Skyhawk,** smallest and lightest U. S. jet combat plane. The single-seat, carrier-based aircraft can carry nuclear bombs or rockets, air-to-air missiles or other weapons to suit a variety of missions.

Powered by a Wright J65-W-2, the midget bomber's speed is subsonic but still faster over greater distances than any other plane of its type. It is designed for a nonstop range equal to a coast-to-coast flight across the U. S.

• **Grumman F9F-9 Tiger,** one of the few military planes now capable of supersonic speeds in level flight. This lightweight fighter has a "Coke bottle" fuselage plus a very thin swept wing and tail for minimum amount of drag at Mach 1.

Experimental F9F-9s get a thrust of more than 7,220 lb. from their Wright J65-W-7 powerplants, and production models will have the added boost of an afterburner.

• **Convair XFY-1 and Lockheed XFV-1,** first known vertical takeoff interceptors. The XFY-1 and XFV-1 have made the transition from vertical to horizontal flight, and the Navy expects one or both of the two design approaches to prove the combat capability of VTO aircraft during flight tests and evaluations this year.

Both interceptors are powered by the Allison YT40-A-14 turboprop, able to deliver its full 5,500 hp. to contra-rotating propellers in either vertical or horizontal attitudes.

With the first experimental VTOs flying, Navy is looking to designs powered by turbojets, ramjets or rockets.

"When we get powerplants with sufficient thrust, we can build VTOs to the same performance parameters as conventional aircraft," says one Pentagon planner. "We have to wait to get the powerplant to get the plane that will have many, many operational uses."

• **Convair R3Y-2 Tradewind,** improved version of the highspeed R3Y seaplane transport. The Tradewind series features a slender, blended hull in an airframe powered by four Allison T40 engines that turn contra-rotating props. The water-based turboprop transports can reach speeds near 400 mph.

Nicknamed the "Flying LST," the 82-ton R3Y-2 has a bow loader ramp large enough to take heavy combat equipment. This lets the new Tradewind taxi to a beachhead during amphibious assaults to unload troops, weapons and supplies.

▶**Fleet Aircraft**—Two of Navy's new and unusual carrier-based designs, the Douglas F4D and A3D Skywarrior, are nearing fleet operation.

Production F4Ds are equipped with Pratt & Whitney J57 turbojets, giving the bat-winged fighter better performance than the Westinghouse J40-powered prototype that set a 753.4-mph. speed record over a 3-km. course in November 1953.

The A3D will replace North American's AJ-2 Savage, interim aircraft designed to fill the gap during the transition from piston-engine to turbojet attack bombers.

The 70,000-lb. Skywarrior—powered by twin P&W J57s slung in pods under high, swept wings—can operate from Forrestal, Midway or Essex-class carriers. It will be able to make high-speed, longrange strikes with nuclear weapons, bombs, torpedoes or mines.

▶**Sea Dart Tests**—One of the Navy's most inventive water-based designs—Convair's supersonic XF2Y-1 Sea Dart, powered by twin Westinghouse J46 jets—still is in an experimental stage expected to prove its hydro-ski landing gear.

"We don't know whether to use a single or double hydro-ski," reports one Navy spokesman. "At the present time, we believe the single-ski configuration is best."

Two new Sea Darts will continue the program, joining with the first XF2Y-1. The second Sea Dart, the YF2Y-1, broke up and crashed in San Diego Bay last November during a demonstration flight.

▶**Improved Breed**—In addition to its new designs, the Navy is improving the breed of aircraft families already in operation. These new models made their first appearance during the past 12 months:

• **North American FJ-4 Fury,** descendant of Navy's first carrier-qualified jet fighter, the FJ-1. The FJ-4's design follows the sweptwing configuration of its three carrier-based predecessors but has mechanically drooped wing leading edge and aileron flaps to improve lowspeed performance, plus other aerodynamic changes.

Powered by a Wright J65-W-4 Sapphire, the new FJ-4 is the fastest of the Fury series and has a service ceiling higher than 45,000 feet.

• **Grumman F9F-8 Cougar,** last of this sweptwing fighter series. The new carrier-based aircraft follows the same general design of the F9F-6 and F9F-7 but has a thinner wing for higher speeds and larger fuel tanks for longer range. Its P&W J48-P-8 also increases thrust by several hundred pounds.

The F9F-8 began carrier-evaluation flights off the USS Midway in late 1954.

• **Lockheed P2V-7 Neptune,** anti-submarine aircraft powered by a combination of turbojet and piston engines. Over targets, the sub killer's twin Westinghouse J34 jets increase its 300-mph. top piston speed by 58 mph. Two Wright Turbo Compound piston powerplants are used for cruising.

In addition to its principal role of sub hunting, the P2V-7 can be used as a torpedo bomber or mine layer.

• **Martin P5M-2 Marlin,** last of Navy's piston-engine flying boats. This newest and largest anti-submarine patrol bomber has higher speed, range and takeoff weight than the earlier P5M-1. It has twin 3,400 hp. Wright Turbo Compounds.

New features of the P5M-2 design include a high T-tail and a low bow chine that cuts spray during takeoff.

▶**Tight Limits**—The Navy's outstanding examples of aircraft engineering result from an inherited advantage. The Bureau of Aeronautics and its plane builders are forced to design to tight operational limits.

Navy's planners believe there is a further limit to where they can go in the near future, based on the state of the art and metals now available.

"In design stages for piloted aircraft, we can't see asking for speeds of more than Mach 2.5 or combat altitudes higher than 60,000 feet," they say.

In bringing a new aircraft from the drawing board to the deck of a combat carrier, the airframe presents less problems in terms of design stages and time than any other major components of a complete project.

The average timetable calls for five years from the day a new requirement is issued by the Deputy Chief of Naval Operations for Air to the first large airframe delivery, compared with seven years for the engine and nine for avionics.

▶**Engine Bugaboo**—Powerplants still are the big bugaboo of Naval aviation. Navy's development program includes no new engines. The last new project, Pratt & Whitney's T52 turboprop, was canceled late last year.

The reason: no money.

Because of this, Navy will depend on engines developed under USAF's program, set up to cover a larger range of aircraft requirements.

In the future, BuAer will try to set up alternate engines for all new airframe designs as insurance against failure of one to meet operational needs or production schedules.

The bureau intended to start its alternate engine program with the Wright J65-powered Grumman F9F-9, scheduling General Electric's J73 for one of the first six Tigers built for test. But the plan was dropped temporarily before a J73 could be installed.

Delays in powerplant development programs last year forced Navy to cancel orders for more than 200 McDonnell F3H-2 Demon fighters and 96 Chance Vought A2U-1s, attack version of the F7U-3 Cutlass. The A2U-1 was designed to use the Navy-developed Westinghouse J46-WE-18, and the F3H-2 was to be powered by USAF's Allison J71-A-2.

Lack of sufficient power was a major reason Grumman's XF10F project did not get past the prototype stage. The Westinghouse J40 turbojet was too small for the experimental Navy fighter's airframe.

Navy Aircraft Types on Order

COMPANY	PLANE	NAME
	FIGHTERS	
Douglas	F4D	Skyray
Grumman	F9F-8	Cougar
	F9F-9	Tiger
McDonnell	F3H-1	Demon
	F3H-2	Demon
North American	FJ-3, 4	Fury
Chance Vought	F7U-3	Cutlass
	ATTACK	
Douglas	AD 5, 6	Skyraider
	A3D	Skywarrior
	A4D	Skyhawk
	PATROL	
Martin	P5M-2	Marlin
Lockheed	P2V-7	Neptune
Lockheed	WV-2	Constellation
Grumman	S2F	None
	TRANSPORTS	
Douglas	R6D	Liftmaster
Lockheed	R7V-2	Constellation
Convair	R3Y-1, 2	Tradewind
	R4Y	None
	TRAINERS	
Lockheed	TV-2	Shooting Star
North American	T-28	None
Beech	T-34	Mentor
	HELICOPTERS	
Bell	HSL-1	None
	HTL-6	None
Kaman	HOK	None
Sikorsky	HSS-1	None

MARTIN XP6M-1 SEAMASTER

Guided Missile Punch

Guided missiles will add to the fleet's airpower punch this year, although Navy experts report they have a long way to go in this field.

"Where we are today in missile development," the Navy experts say, "is where we were 30 years ago in Naval aviation."

But they forecast the day when guided missiles will replace shortrange interceptors in fleet air defense and become a major surface-to-surface weapon of large warships.

Under this planning, all cruisers would be armed primarily with surface-to-air missiles. Eventually battleships

would be equipped with guided missiles for air defense and surface-to-surface offense, becoming a single-ship task force for limited combat.

▶ **Advanced Projects**—Navy's advanced guided missile projects so far include:

• **Convair Terrier**, scheduled to make its appearance with the fleet this spring on the first all-guided-missile heavy cruisers—the Boston and Canberra.

This surface-to-air weapon's evaluation tests ended in November 1954 with launchings from the battleship Mississippi. Rocket-powered, the 3,000 lb. Terrier has a top speed estimated at Mach 2 and a range of approximately 20 miles.

• **Chance Vought Regulus**, surface-to-surface missile designed to carry a nuclear warhead. It now is operating off the submarine USS Tunny. The sweptwing Regulus is powered by an Allison J33 turbojet, weighs about 15,000 lb.

• **Sperry Sparrow**, air-to-air missile now being tested by a jet fighter squadron in both fleet and shore evaluations. This 300-lb. delta-wing weapon has a solid-propellant sustainer that pushes the Sparrow to a burnout speed estimated at Mach 2. Approximate range: 5 miles.

The Navy plans to convert several heavy cruisers, now stored in "Red Lead Row," to all-guided-missile ships. But Pentagon planners say the time will come when it will be cheaper and faster to build these ships from the keel up.

Super Aircraft Carrier

The bulk of Navy's airpower centers on its floating air bases—the aircraft carriers. These ships have grown from the 27,000-ton Essex-class of World War II to the new 59,600-ton Forrestal, first of five new super carriers.

To the Navy, the Forrestal represents a new air-sea concept in thermonuclear war strategy. To supporters of land-based airpower, the $200-million carrier represents money they believe is needed for high-speed, long-range bombers.

▶ **Airpower Debate**—Britain's Field Marshal Montgomery revived this basic airpower debate, predicting land-based aircraft soon would control the seas and advising the United States to stop building carriers.

James H. Smith, Jr., Assistant Secretary of the Navy for Air, replied that the carrier is America's most practical air base. The mobility of carriers and the unpredictability of their courses make them less vulnerable than land bases.

To this argument, Air Force backers in the United States countered that the seas cannot hide ships from location by modern radar and attack by jet aircraft or far-ranging submarines.

▶ **Defense in Depth**—But Navy believes it would be hard to cripple its new task force of three large carriers of the Forrestal (CVB) or Midway (CVA) class, seven cruisers and two supply ships.

It would spread over an area too wide for any weapon to damage seriously more than one ship.

And the task force would have defense in depth, with helicopters flying anti-submarine and early-warning missions on the picket lines and interceptors and guided missiles forming an umbrella of protection overhead.

▶ **'Buddy System'**—Aircraft launched from these task forces soon will be able to hit far inland at enemy industrial centers, countering arguments that air-sea teams cannot deliver a knockout blow because of limited 700-to-1,000-mile range.

This range will be increased by a new aerial refueling concept that will give every carrier-based aircraft a dual role, operating as either a combat plane or a tanker. There will be no specialized tanker squadrons similar to those used by the Air Force.

Under this plan, a "buddy system" would split a 36-plane group into 18 tankers and 18 combat aircraft on long-range strikes that demand inflight refueling. On short missions, the tankers would revert to combat roles.

NAVAL AIRCRAFT ON HAND

1954

Operational Navy aircraft	10,000
Active logistic aircraft	2,500
Inactive Navy aircraft	2,500
Total	15,000

The standard for this operation calls for aerial refueling systems that would allow quick convertibility aboard carriers, fast transfer of fuel and high reliability.

For non-carrier aircraft, seaplane tankers such as the Martin P6M now are in the planning stage.

Air-Ground Task Force

The Marine Corps proved its new atomic concept of a vertical-envelopment beachhead assault recently on Nevada's Yucca Flats.

After a nuclear bomb knocked out "enemy" forward positions, three helicopter squadrons lifted two battalions of riflemen over the "hot" area in a follow-up attack.

In actual combat, the troops would be protected from enemy aircraft by surface-to-air Terrier guided missiles, adapted to beachhead launching sites for Marine tactical operations, and by fighter covers armed with air-to-air Sparrows.

▶ **Assault Vehicles**—Sikorsky's HR2S-1 comes closer to filling the bill as the assault helicopter for this operation than any other currently operational rotary-wing aircraft. The Leathernecks must have a copter able to lift the weight of many troops but small enough to fly off a carrier.

Launching site of the attack will be an escort carrier converted to an assault transport for troops and copters.

▶ **Tactical Wings**—Marine airpower is broken up into three wings, one for each ground division. The wings must provide close air support, maintain air superiority over assault areas. Each has nine squadrons.

Supporting the tactical forces are three transport groups and two general composite squadrons, set up for airborne early warning and aerial photo-reconnaissance missions.

The Leathernecks hope to make the transition from piston-engine to turbojet-powered aircraft in 1956. In addition to the A4D attack bomber, they want the Douglas F4D, Grumman F9F-9, Chance Vought F8U-1 and North American FJ-4.

Of the Marines' current combat planes, the Douglas AD Skyraider is the only one powered by a piston engine. Jet-powered aircraft include the North American FJ-2 Fury, Grumman F9F-4 and -5 Panther, F9F-6 Cougar, Douglas F3D Skyknight and McDonnell F2H-2 Banshee.

▶ **Copter Groups**—To update its three helicopter groups, the Marine Corps expects to take delivery this year on Kaman's HDK, described by Leatherneck airmen as the "greatest thing since Hadacol." This copter gradually will replace the interim Bell HTL and Sikorsky HO5S.

Also upcoming are two one-man portable rotorcycles, the Hiller XROE-1 and Cyrodyne XRON-1.

Combat Capability

The new air-sea teams and air-ground forces resulted from combat capability plans set up to keep the Navy and Marines in constant readiness for war.

"If the balloon bursts tomorrow, our people will know what to do with what we have now," says one Navy official.

Superimposed on the emergency plan is a four-year program designed to estimate what manpower and equipment the Navy will need by 1959, strengthen weak spots and stockpile resources.

The Navy says its airpower requirements require a constant, sensible reappraisal—rather than an occasional new look.

MAJ. GEN. J. H. GAVIN

CESSNA T-37

Army Wants Air 'Cavalry' and 'Trucks'

By G. J. McAlhster

The U.S. Army is looking to aviation to bridge the gap in combat capability between its reduction in manpower and its military mission.

The solution, Army planners say, is two-fold:

• **Flexibility** in overseas deployment of division-size units through the use of transports such as the Douglas C-124 and the C-118, and, for the future, large turboprop transports such as the Lockheed C-130 and the Douglas C-132.

• **Tactical mobility** in a theater of operations through employment of helicopters as well as small fixed-wing aircraft.

The Air Force frankly admits that it cannot at the present time fulfill the Army's airlift needs. Lt. Gen. F. F. Everest, USAF Deputy Chief of Staff for Operations, said the Air Force today could not airlift one complete infantry division. The Army's goal is an airlift potential with the capability of picking up and moving at least four combat divisions.

▶ **Whose Airlift?**—Army is not pressing USAF directly for an airlift increase. The position, as told AVIATION WEEK by Maj. Gen. Paul D. Adams, Deputy Assistant Chief of Staff for Operations:

"We must have airlift to carry out our mission. The service that provides it doesn't concern us. We would welcome Navy airlift."

Gen. Adam's office is decorated with models of two new Navy aircraft: Convair's turboprop R3Y and Martin's four-jet P6M.

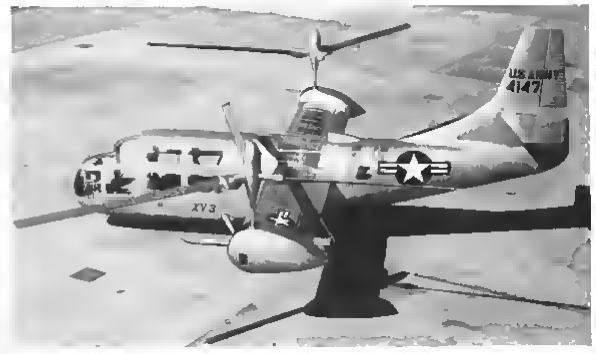
At the same time, Army wouldn't mind having the assignment itself. Army now is limited to fixed-wing aircraft of not more than 5,000 lb. empty weight through the provisions of a "memorandum of understanding" with the Air Force of Nov. 4, 1952. There is no limitation on helicopter weights. Army believes the limitation should be on function and not weight.

▶ **Ground Fight**—Support for the Army's position on more airlift is mounting in Congress. Sen. Stuart Symington, former Secretary of the Air Force, is backing the Army's case. His view on airpower is a bellwether for the Democratic position in Congress.

" . . . I have studied the airlift situation over recent weeks," Sen. Symington said, "and believe the airlift available to the Army is inadequate. . . .

"If there now is atomic stalemate, then it is certain that any new hostilities will result in fighting on land—and I for one have always believed that any

SIKOKSKY H-37



BELL XV-3 CONVERTIPLANE

DE HAVILLAND OTTER

war of any kind will involve fighting on land. They always have, and they always will," Sen. Symington said.

This is in line with the Army's viewpoint. A top staff officer told AVIATION WEEK:

"Supposing the National Security Council had decided to send troops into Indo-China. If we had been able to lift and support a division by air the military value of the move would have been immeasurably increased. It may even be that our decision not to go into Indo-China was influenced by our lack of airlift."

▶ **What Kind of War?**—The problem turns on two basic questions. What kind of war will we fight? Lacking a positive answer to that question, how many alternatives can we afford?

One viewpoint sees the intercontinental bomber or missile force, equipped with thermonuclear weapons, as the overwhelming, perhaps only, factor in national security. Another envisages a long series of fringe wars—none of them of sufficient individual importance to warrant use of large-scale nuclear weapons against the Russian homeland.

Manpower

Spokesmen for the Army claim that the manpower reduction will seriously cripple its ability to carry out follow-up action after strategic bombing. The argument is not anti-airpower. Army Chief of Staff Gen. Matthew B. Ridgway says the Army needs the mobility of airlift because it will "largely determine the promptness with which United States ground troops can exploit the effects of strategic air attacks upon the enemy."

In the fringe war alternative, the Army is up against a mathematical problem. How many fringe wars equal an all-out war?

▶ **Effect of Manpower Cut**—It appears that the Administration's views on manpower assignments will prevail. It has the personal approval of Commander-in-Chief Eisenhower, a onetime Army Chief of Staff. And Rep. Carl Vinson, chairman of the House Armed Services Committee, has said that he would support the President's plan.

Army strength will be approximately 1,027,000 men in 1956, down about one-third from the average strength maintained during the Korean War, which was 1,500,000 men.

However the ball may bounce on manpower, the Army is moving ahead with plans to increase its use of aircraft to gain mobility.

"The proposed cut only increases the urgency of acquiring more mobility through use of aircraft in the field," says Col. W. R. Williams, chief of the Army's Aviation Branch, G-3 (Operations), "and it must be organic mobility directly under the control of the Army field commander and not dependent on an involved chain of liaison command."

The use of aircraft in tactical operations is a logical progression from land-bound vehicles, Col. Williams says.

Army is employing numerous different arrangements of its squad units in the important exercises, Blue Bolt and Follow Me. The eventual shape of Army airborne units may largely come from the lessons learned in these exercises.

One significant part of the exercises is beefing up the aircraft complement in divisions by 30%.

'Cavalry'

"The use of tactical nuclear weapons means greater dispersion and more fluid operations," Col. Williams predicts. "The reconnaissance elements will have several times the area to cover compared with the past. The tank is not fast enough to find targets for nuclear weapons, and its use is limited by terrain and roads. Aircraft are the answer."

The Army visualizes the tactical employment of aircraft in the same way cavalry was used in the Civil War.

Gen. Adams says: "Jeb Stuart would have loved to do it this way."

A new organization, which is scheduled to replace the present reconnaissance unit this summer, will consist of three elements with specific equipment and characteristics.

- **First element** would be strictly observation. Equipment would be two-man helicopters such as the H-13, to find the enemy and radio the situation back to a field headquarters.
- **Second element** would be an assault or blocking force carried into action by larger helicopters such as the H-21. Equipment would include rifles, machine guns and mortars. The unit would have the capability of fighting a sustained action.
- **Third element** would be a unit of tanks similar to the present organization.

Value of this type of organization, Gen. Adams says, is that it increases capability and decreases the need for men. The Army is also conducting extensive studies on the use of electronic devices to patrol gaps in ground battle lines. These devices would pick up movements of men and machines within an assigned area, automatically report the information to a central control center.

FAIRCHILD C-123B

▶ **Key Is Flexibility**—One of the strongest proponents of aviation in the Army is Maj. Gen. James M. Gavin, Assistant Chief of Staff for Operations.

"We can't stay in the same league with Russia unless we have flexibility. Just as democracy itself is flexible, the weapon systems that defend it today must likewise be flexible. That flexibility comes from air mobility," Gen. Gavin says.

"I foresee the integration of the airplane in every unit of the Army. We need all types of aircraft. If we should stick to just a small family of airplanes we would become inflexible and negate ourselves," he says.

Gen. Gavin has come up with an equation to describe his thinking. Battlepower = weight × mobility.

Supply

Gen. Adams predicts a much greater use of aircraft in supply work. "The day of big supply dumps in a theater is over," he says.

"We may find it necessary not to permit any supplies at the front except those consumed on a day-to-day basis.

"The supplies will be delivered by air daily directly to the consuming combat units. That way we cut out intervening supply points.

"This will increase the mobility of our columns which will not be weighted down with extra equipment. We figure that we will only need about one-third the number of aircraft to do the job presently done by trucks. This is because they can make several trips while the truck is making one. The additional men required for the aerial supply work would be more than offset by fewer men in truck companies," Gen. Adams said.

"Use of aircraft doesn't pose any new problems. They can be dispersed to a greater extent than trucks; concealment is simple, too," he says.

Gen. Adams says progress toward the goal of increasing use of aircraft is bound by the present availability of aircraft and the Army's experience in using them.

▶ **Copter Problems**—The Army's helicopter program has lagged because of troublesome maintenance and development difficulties. The maintenance troubles have been the subject of brisk and outspoken conferences between the Army and the manufacturers of helicopters.

Army complains the aircraft are too complicated and lack field reliability.

BEECH L-23B

The manufacturers counter with charges that Army specifications do not permit sufficient design and performance leeway.

Army also is irritated by the present system of handling its aircraft procurement and research and development through the Air Force. Most of the industry would prefer dealing directly with the Army since it would eliminate time-consuming delays in clearing contract changes and engineering modifications.

There is a growing possibility that the Army this year may obtain more autonomy in its aircraft program.

Army Types on Order

Army is currently purchasing the following fixed- and rotary-wing aircraft:

Company	Designation	Type
Cessna	L-19	Observation
De Havilland	L-20	Utility
Beech	L-23	Command
Cessna	T-37	Observation
De Havilland	X	Cargo
Bell	H-13	Reconnaissance
Sikorsky	H-19	Utility
Piasecki	H-21	Cargo
Hiller	H-23	Reconnaissance
Piasecki	H-25	Reconnaissance
Sikorsky	H-34	Cargo
Sikorsky	H-37	Cargo

X—No military designation. Company designation is DHC-3.

In addition, Army plans to purchase a limited number of the Bell Model 212 helicopter, winner of the recent Army competition for a new utility copter (AVIATION WEEK Feb. 21, p. 18).

▶ **Aircraft on Order**—The Army is buying two new aircraft this year. They are the de Havilland DHC-3 Otter, successor to the Beaver, and the Cessna T-37A jet trainer.

- Otter is a single-engine aircraft capable of carrying 14 fully equipped infantrymen and extra ammunition. It can operate from runways of 1,000 ft. and less. The Army designated the aircraft the C-137, but this was turned down by the Air Force which insists the plane should have an "L" (for Liaison) designation. Army order is for 84 aircraft.
- T-37A will be the Army's first jet-powered fixed-wing aircraft. It was ordered because present piston-powered observation planes are unable to carry out the mission of observing and adjusting fire for the Honest John rocket, Wac Corporal missile and the 280-mm. atomic cannon. The T-37A has a speed of more than 350 mph. Army has ordered 10 of these two place planes, a service test quantity.

▶ **Convertiplane Interest**—Army is demonstrating a keen interest in the convertiplane, both as a troop and cargo carrier.

Latest model to roll out is Bell's XV-3 which features a tilting rotor arrangement.

▶ **Budget Higher**—Growth of aviation is readily apparent in new budget figures for the Army. The Army in fiscal 1955 will spend $69 million for aircraft; in fiscal 1956, expenditures will increase to $118 million. Major part of the expenditure increase is for Sikorsky H-37 transport helicopters.

President Eisenhower in his budget message told Congress that ". . . the Army will maintain 3,600 active aircraft, with more than a 20% increase during the next two years in the number of helicopters."

Gen. Gavin puts in bluntly: "Divisions must move by air. When they get to the overseas point they must again move by air. If we can't do that, we are not in the business of survival."

NATO Improves Its Aircraft, Training

By John Coppock
(McGraw-Hill World News)

Paris—Western Europe's air forces are somewhat larger and a great deal better than they were a year ago. The outlook for the coming year appears to be more of the same—a little more strength, a lot more punch.

This is the overall conclusion to be drawn from the replies to a series of questions put by Aviation Week to Supreme Headquarters, Allied Powers in Europe (SHAPE).

With something over 6,000 aircraft assigned to SHAPE in Europe at the beginning of 1955, effective numbers showed an increase of 20% over the previous year. When Gen. Eisenhower took command at SHAPE four years ago, he had one-third this number of planes available.

But, in the words of a SHAPE spokesman, "qualitatively there is so great a difference that there is really little basis to permit comparing the forces available at the end of 1954 with those which were available . . early in 1951."

The underlying basis for the improved air situation in Western Europe is to be found in a whole series of developments.

Equipment

While deliveries of new European-built aircraft have been delayed, a steady flow of U. S. planes has permitted formation of new units and the re-equipping of others.

While Britain's Hunters and Swifts and France's Mysteres lagged behind schedules, late models of the U. S. F-84 and F-86 were delivered to Europe in quantity under the Mutual Defense Assistance Program in 1954. Deliveries of new planes did not come up to expectations or hopes, but military authorities were not seriously disappointed by the year's record.

▶**Stockpile 'B'**—While NATO authorities do not discuss the supply situation in direct connection with 1954's failure to bring a German contribution to Europe's air defenses, there is little question that the two are related.

For several years the Pentagon has maintained an item on its military-aid program known as "Stockpile B," for the initial equipping of German forces if and when they are authorized. "Borrowing" from this stockpile as German rearming has been delayed has made possible smaller deficiencies in the equipment of other NATO forces.

This delay, along with generally lower force goals, has undoubtedly permitted a reasonably adequate supply of long-lead-time items like aircraft needed for existing and planned forces in most Western European countries.

Airfields and Logistics

According to SHAPE, "The logistical situation must never be considered satisfactory. In time of peace to accept the prevailing logistical situation as satisfactory is to court possible defeat in time of war . . ."

After that word of warning, the SHAPE spokesman continues, "It may truthfully be said that progress is being made, but improvements are always needed."

▶**Infrastructure Situation**—NATO forces had available to them by the end of 1954 a total of 132 airfields in usable shape, though not all of them were completed.

According to SHAPE, the overall program for 165 fields should be completed during 1955. Of the total, 135 will be in NATO countries, 30 in Western Germany.

Operations at fields is said to be improving, with improved supply systems gradually taking hold. Problems remain, of course.

In SHAPE's view, there is plenty of room for progress in the standardization of equipment, development of cross-servicing agreements, and improved training programs for handling new and more complex equipment.

Training

SHAPE believes that "training facilities and operations are generally adequate to meet the task at hand."

Great progress has been made in air training, long considered a weak link in NATO's air force program. There is little doubt that this bettering of the training program is closely linked to the scaled down force goals which now control NATO planning, reducing the necessary intake of new manpower and making available budgeted funds for training which previously was earmarked for expansion.

▶**Room for Improvement**—But SHAPE admits that weaknesses, if less glaring than heretofore, still exist.

"These weaknesses," SHAPE says, "are those normally experienced by air forces which are undergoing rapid expansion and modernization. . . . None of these problems is extremely critical or unsolvable. The major weaknesses in almost all cases may be attributed to non-availability of certain air or ground training space and/or to insufficient budgets for the support of all requirements in the training program."

In connection with pilot training and NATO's recent search for more effective jet trainers, SHAPE says "there is no attempt being made to select and use any one aircraft as a NATO jet trainer."

On the basis of reports of NATO's Military Agency for Standardization after last year's trainer competition, rumors have circulated that a strong official nod would go to the French Fouga CM 170 R.

▶**West Germany's Share**—According to SHAPE, formation of German air units when the Western European Union treaty comes into force and West Germany becomes a member of NATO will not provide any serious problems so far as can be foreseen. SHAPE was understandably disappointed that a start on the German air force was not possible last year.

But when that day finally does arrive, "there appears to be no special training problems prevailing in the formation of West German air units. It is expected that the training will be accomplished in a manner commensurate with the planned flow of equipment to the German Air Force."

Queried on the meaning for NATO's air forces of the decision to base planning on the use of tactical nuclear weapons in Europe, SHAPE spokesmen fall somewhat short of a precise answer.

"The North Atlantic Council, in recognizing the need to plan on the basis that nuclear weapons would be used in a major war, essentially recognized that the training, disposition and utilization of air forces should be adjusted to the dictates of atomic warfare.

This now permits the drafting of plans that will most effectively utilize the capability of these weapons in aerial warfare," SHAPE says.

▶**Mainly Fighters**—NATO's air forces remain essentially a none-too-numerous but an increasingly-proficient group of interceptor and ground-support units.

Bombers play little part in the organization, and there is apparently no plan to expand this element of airpower within the NATO framework. U. S. bombers based largely on the periphery of Europe continue to provide the strategic air punch for our European allies.

BISON AND FRESCOS fly across Red Square in this official Russian photo ● USSR

Engine Progress Boosts Red Airpower

Three major technical advances in Russian airpower were flaunted in the face of the West during last year's May Day parade in Moscow:

- A four-jet, longrange bomber prototype with highly tapered, swept wings, in a size class with USAF's Boeing B-52.
- A squadron of new twin-jet medium bombers of contemporary design, comparable to the Boeing B-47.
- A huge axial-flow turbojet, estimated to produce upwards of 15,000 lb. thrust, that powered both new bomber types.

Flying at the wingtips of the big bomber as escorts were four MiG-17s, a development of the MiG-15 standard jet fighter of the Red air force and satellite countries since 1948.

The entire flypast was, for the second year in a row, an all-jet demonstration

▶ **Sound and Fury**—These first public appearance of new Soviet designs apparently were part of a carefully planned propaganda campaign aimed at promoting the power of the Red air force

"There is no question that the Reds were anxious for the representatives of other nations in Moscow to see their new bomber. They rehearsed the show several times and always flew very low," said Gen. Nathan F. Twining, USAF Chief of Staff.

"Both of these new bombers had been carefully hidden up to that time. That the Reds intend to impress and to frighten us with their aeronautical progress and with the advanced design of their new jet bombers and their new jet engines is clear," he added.

▶ **Red-Letter Day**—On the heels of the May Day surprises came Soviet aviation day June 20, featuring almost 700 aircraft in a sky-searing display over Moscow's Tushino airport. About 450 of the participating planes were jet

BADGER (TYPE 39) twin jet medium bomber in B-47 class, shown in official Navy drawing prepared as recognition aid

MIXED MIGS—15s, 17s and 19s—whistle through Iron Curtain skies in photos from usually reliable source.

powered.

Timed to coincide with the public demonstration were four additional propaganda efforts:

• **A preview of the display,** written by designer Artem A. Mikoyan (MiG-15 and MiG-17), that hinted at the appearance of a supersonic aircraft (AVIATION WEEK Sept. 20, 1954, p. 30). Mikoyan referred to planes with more sweepback and probably meant his MiG-17.

• **Speed record claim by Moscow Radio,** asserting that a Red test airplane had reached a mark of 1,659 mph. At altitude, this corresponds to a Mach number of approximately 2.5, the current recognized speed mark of Mach 2.5 was set by USAF Maj. Charles Yeager in the Bell X-1A in December 1953.

• **First flapping-wing glider** was promised by Moscow Radio on the eve of the Tushino display. It showed on the following day to delight the crowd. But Mikoyan was not enchanted, his article said: ". . . we no longer need to imitate the free flight of feathered creatures." Most engineers would agree, the chief value of the ornithopter is as an aeronautical curiosity.

• **First official Russian pictures** of the four-jet bomber and the MiG-17s were printed in Soviet papers and released in the Western world. Picture was of usual poor quality, but illustrated the unusual aerodynamic shape of the big bomber very well.

▶ **Bluster or Bruisers?**—Biggest job for Western intelligence observers is to evaluate Russian airpower potential on a grand scale, based on a few tangible pieces of evidence.

The existence of a single prototype bomber would not normally be construed as a menace to the free world. The big four-jet bomber that flew across Red Square might have been a prototype, or it might have been one assigned to the demonstration from an operational squadron. The all important question is which it was.

Another aspect of a single plane or a new-model appearance. Do the design features indicate that Red engineers are working with contemporary knowledge?

Without specific knowledge to questions like these, there can only be conjecture and extrapolation from airplanes to airpower. This is the biggest single reason that Russian military strength continues to be an enigma.

▶ **What They Mean**—To most observers of Russian airpower, the shock was not the bombers, it was the knowledge that the Reds had produced and were using an enormous turbojet with a thrust rating estimated at upwards of 15,000 lb. Some informed speculation that this was a ducted-fan type of engine was not a consoling thought, either.

This fact remains. There is no comparable operational engine in the Western world.

At least three U. S. engines now in development are aimed at that thrust figure, including Pratt & Whitney's J75 and Wright Aeronautical's J67. In England, the Rolls Royce Conway, a ducted-fan engine, is pointed toward a thrust near that value, and Bristol is heading upwards in the ratings of the Olympus, now type-tested at 11,000 lb. Sneema's Vulcain, French engine type-tested at 13,200 lb., is a dark horse in the power race.

All these are test stand or development engines, and are at least one year from experimental installation in any airframes.

▶ **Power Upstairs**—The altitude performance of Russian turbojets has long been the subject of bitter comment from Korean combat veterans. "We're still tired of looking up at them," said one commander.

It is not a matter of hundreds of feet, but of thousands. The Reds held an advantage of at least 5,000 ft. during the entire Korean war.

This is an indication of the state of the art in turbojet design. Altitude performance depends largely on the compressor, which must furnish air at a density high enough to support a flame. Engines flame out because the air in the combustion chamber gets below that density.

It is reasonable to assume that Russian knowhow in altitude performance has been included in the big 15,000-lb. units. The combination of enormous thrust and operational ceilings well above 50,000 ft. would work to their advantage two ways. It would provide a safety margin for their bombers and it would give their interceptors the ad-

MIKOYAN all weather fighter is provisional designation of this design, shown in photo from Aviation Week source. Tail shows MiG lineage, but wings are new.

vantage over our bombers.

With powerplants available in this class, Red designers are freed temporarily from many of the limitations that harass their Western counterparts.

▶**Behind the Scenes**—The surface news is bad enough, but what lies below the surface is more serious. Production engines in that category mean that during the relatively short postwar period of eight years, Russian engine technology has pushed powerplant development from copies of low-power German wartime engines to units which dwarf those of the U. S. and Britain.

To do this requires basic knowledge in many fields: aerothermodynamics, mechanical design, metallurgy, combustion, lubrication. It requires large development shops, staffed with highly skilled mechanics who can turn out the single prototype engines for test, and who can build a limited series of engines for service test.

It requires a major capital investment in test stands and flying testbeds, in spin pits and gearbox run-in stands. It requires large foundries, massive machine shops and quantities of skilled and semi-skilled labor.

This supporting base is the real cause for worry when you think about Red powerplant prowess.

▶**In the Air**—Accepting the advanced state of Russian engines, the observer turns to a study of Red aircraft lines.

The big bomber is a case in point. Its layout shows that the designers were building for altitude operations over long range.

They chose a low wing loading and high aspect ratio, both the traditional criteria of efficient longrange flight. Wingspan is about 180 ft., comparable to the 185-ft. distance of the Boeing B-52.

Sweepback is on the order of 30 deg. The leading edge of the wing changes angle at about midspan, and the trailing edge breaks just outboard of the powerplant. Both these changes provide extra chord—and therefore extra available thickness—for the semi-buried powerplants.

Fuselage and tail are typical of the early postwar era and show no particular attempt to clean up the lines. The vertical surface has some small amount of sweepback, but the horizontal tail is unswept.

This curious reversal of the usual aerodynamic practice of sweeping the tail on a straightwing airplane (as in Lockheed's F-94C or Ilyushin's Il-26 series) poses the problem of why the designers did that.

One engineering estimate: Red structural knowledge lags that of this country. The inability of the Russians to build large-span, thin wings forced them to fairly thick sections, and they had to sweep the wing to raise the critical Mach number.

There is another and cynical attitude. Before the days of compressibility, there used to be a saying that if you saw an airplane with sweepback, it was because the designer hadn't estimated his center of gravity correctly.

▶**Newer Lines**—Of greater interest is the advanced layout of the Type 39 twin-jet bomber that burtled across Red Square in a group of nine planes. It has the trademarks of an Ilyushin design.

Wings are swept, and mount the big turbojets snugly against the side of the fuselage. Leading edges are cranked, increasing the chord toward the wing-fuselage intersection. Paired boundary-layer fences are mounted on the upper surfaces. Large streamlined pods slip over the trailing edge of the wing and probably carry part of the fuel supply.

Engine inlets are preceded by ramps and provide for boundary-layer bleed in the accepted manner.

Size and design of the plane have been declared comparable to those of the Boeing B-47 by Gen. Twining.

▶**Fresco and Falcon**—In the fighter field, the most recent addition to the Red air force is the MiG-17, code-named Fresco by the U. S. military.

Fresco is to the MiG-15 (Falcon) as the F-86H is to the F-86F. There have been some aerodynamic improvements, power has been increased, and the lessons learned in Korean combat have been fed into the layout. But the MiG-17 is only a slight development of the MiG-15, is probably not supersonic in level flight.

Fresco, Badger (the Type 39 twin-jet bomber) and Bison, the big four-jet job, are the new products demonstrated on May Day.

▶**Other Sightings**—There have been unofficial reports of a large straightwing turboprop bomber, powered by four engines. Press reports emanating from Germany have credited this plane to a new member of the Russian design hierarchy: Miassischtschev.

It now appears that there is also a four-turboprop sweptwing bomber to be credited to ace designer Sergei Ilyushin. An East German publication, in an article on "A great engineer—S. V. Ilyushin"—refers to the Il-13, a "mighty longrange bomber that is equipped with turboprop powerplants." The article presents profile drawings of all of Ilyushin's better-known designs, and shows the Il-13 as a low-wing configuration with modest sweepback on wings and tail.

The same article corrects the designation mixup of Il-26 and Il-28 by showing the former as the straightwing, sweptfin layout. The Il-28 has a straight wing and tail, and is apparently the forerunner of the Il-26 although numbered after it.

▶**Other Areas**—Recently, German scientists who spent the postwar years continuing their projects under Russian eyes have been returning to Western Germany. Whole design teams have come back, with their families shipped on ahead of them, in complete freedom.

The interesting aspect is that apparently the Russians have exhausted them of the special knowledge they wanted to get, and have not wanted to let them continue to work on new projects.

BISON (TYPE 37) four-jet bomber shown in official Navy Dept. artist's conception was one of three new types shown last May Day.

● USSR

in Russia. But before these scientists were allowed to leave, they went through a "decontamination" period during which their work was confined to non-classified aspects of non-military and non-aviation industry.

▶ **Transport Enigma**—Another enigma in Russian air strength is air transport. What little Western observers have seen of airlines inside Russia has not been impressive.

Marshall MacDuffie, writing an outstanding survey of Russia called 'Red Carpet,' says that during his entire trip—which covered most of the southern and western provinces by air—he only saw one four-engined transport. Most of his travel was in Il-12 light transports comparable to the Convair 240 or in the La-2s, which are redesignated Douglas C-47s from wartime Lend-Lease.

The importance of air logistics to a strong air force in being is self evident, yet competent observers like MacDuffie, who have been through major centers of troop transportation, report only small movements by air.

▶ **Training**—There has been little or no knowledge on the pilot training programs in Russia and the satellites. The "on the job" training in Korea showed itself by the sloppy tactics of MiG 15 pilots during their first appearance at the front.

Defecting Polish pilots who fled to Denmark had logged a surprisingly small number of hours to be flying jets on routine operations.

But the entire scope and program of pilot training remains a cloudy vista.

▶ **Ahead in Missiles?**—So does the Red missile program. The only sure information is that they took over Peenemuende and a few scientists, the bulk are now and have been in this country since the end of the war, now stationed at Redstone Arsenal, Ala.

But well-informed officials like Sen. Stuart Symington have stated that Russia is ahead of us, particularly in the development of the intercontinental ballistic missile.

Thus to the interested observer—and, one suspects, to many intelligence specialists—Russian air strength continues to be a mystery seen through the glass darkly.

But although it isn't possible to assess the effort exactly in terms of numbers or tons or personnel, there can be no mistaking the deadly seriousness of the game, and the value of the stakes.

The race for technical superiority is on, and has been since the first Russian atomic bomb was detonated. The appearance of a heavy bomber, modern medium bombers and extremely powerful engines serve as a new benchmark from which to measure Red aeronautical progress.

It has been amazingly swift.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MARTIN MATADORS at Bitburg Air Base, Germany, are posed for flight while an F-86 Sabre flashes by to demonstrate the flight path

Missiles Move Into Operational Lineup

By David A. Anderton

Six service missiles now are in stock in the military arsenal of the United States, with at least two more ready to join them.

Corporal tactical missiles and Honest John ballistic rockets arm U. S. field artillery batteries in Europe.

Nike anti-aircraft missiles are spotted in more than 100 sites protecting 13 major U. S. cities.

Terrier anti-aircraft missiles and Sparrow air-to-air weapons are moving into Fleet units after two years of intensive testing by the Navy.

Matador tactical missiles with medium-bomber range have been deployed by USAF in two operational squadrons in Germany; more squadrons are training in this country.

This transition from service test units to operational use is the outstanding missile development of the year just past and a most significant step forward in the technology of the new weapons.

▶**Early Yield**--With the exception of Honest John—actually not a true guided missile because it lacks in-flight guidance—these weapons now in service are the first fruits of the postwar missile program.

Most of them date in concept back to 1946, their development was frozen and production ordered by K. T. Keller in 1951, while he was head of the Office of Guided Missiles.

Although the basic operational ideas have not changed since then, the refinements of doing the job have not been static.

Nike, for example, was developed to counter the Russian Tu-4, an adaptation of our Boeing B-29. The general kill equation currently could be stated as one Nike equals one Tu-4. Continuing improvements in reliability and accuracy have given the Army hope that Nike could cope with better Red aircraft. In this case, the kill equation might have to be three Nikes for one Russian jet bomber.

As a comparison, without continuing improvement, the kill equation might have to weigh ten Nikes against one Red jet.

▶**Field Operations**—The rugged service-test programs of the Army, Navy and Air Force have paid off in the quick transition to operational use.

Army has been using White Sands Proving Ground more and more as a simulation of battle conditions, where batteries train in operation and firing of their weapons. Before this, they go on convoy over the desert to a remote site and set up a battery under field conditions. The heavy handling that missiles get under this treatment soon points out obvious failings in equipment reliability.

Navy, with its unusually stringent test requirements, has spent two years of intensive airborne and shipboard work straightening out Sparrow and Terrier, learning how to handle 20-ft. long shells and 8-in. diameter aircraft ammunition.

Air Force expended dozens of Matadors in test firings, flying orbits over Holloman AFB and downrange at Patrick AFB, with a chase aircraft standing by.

Jointly, contractor and service personnel have sweated in the desert and frozen in the Arctic, testing and operating under extremes of weather and range and firing site conditions. Out of these thousands of man-hours have come the reliable operational missiles of today.

VOUGHT REGULUS is recoverable missile test vehicle. Parachute drogue slows landing

CORPORAL is erected on launcher for test firing at White Sands Proving Ground.

▶**Scientific Progress**—Meantime research and development has progressed in the engineering offices, laboratories and test stands. Basic advances have been made in every field of missile technology from the science of aerodynamics to that of structures.

Specific highlights include:

▪ **All-aluminum rocket motor** developed by Bell Aircraft Corp. Heat transfer problem, which stymied engineers in motor design for years, has been licked in this unique engine by application of a simple and basic principle.

● **First full-scale tests** in the engine altitude facility at USAF's Arnold Engineering Development Center. Among the powerplants tested was a large missile ramjet developed by engineers at Army's Redstone Arsenal, Huntsville, Ala.

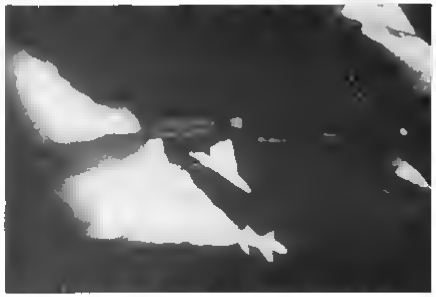
▪ **Guidance progress** in every type of system, traced to increased avionic reliability and better magnetron and klystron tubes.

▪ **Advances made** in aerodynamic theory that permit more extensive use of

Honest John rockets arm the 3rd Field Artillery Battery (Rocket) starting to move out on reconnaissance.

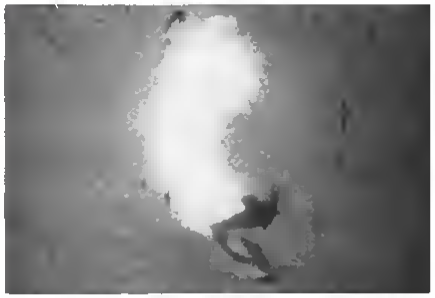
Launcher is elevated for performance checkout and then Honest John roars off toward distant target.

Sperry Sparrow, air-to-air missile, joins the fleet after two years of intensive testing like this:

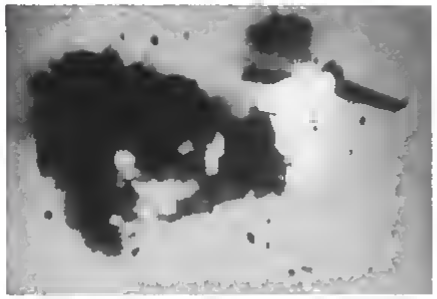


FIRED from attacking Douglas F3D, Sparrow rockets toward

DRONE Grumman Hellcat with only split seconds to live



STRIKE! Sparrow blasts drone with lethal warhead and . . .



TARGET aircraft blazes furiously in death dive.

analytical methods. A specific aerodynamic contribution has been the development of a new airfoil section with the trailing edge portion cut off square instead of tapering to a fine edge. The section is one of optimum drag-structural relationship.

• Better structural design based on understanding of the actual life and operating conditions applied to a missile. Long life, high-strength structure is wasteful if the missile has a total life cycle measured only in minutes. In one specific example, a missile body section now weighs only 38% of what it would have weighed about 10 years ago.

▶ Detail Design—Much experimental and test work with missiles has produced unusual new design details. One of these is a toroidal pressure vessel, replacing the early spherical design, and much more amenable to packaging within the limited confines of a missile envelope.

Contractor experience with missile systems has educated some of the design personnel, formerly schooled in standard aircraft practice. They have learned tricks from the automotive engineers who have contributed to vehicle design and launcher details.

The engineers, formerly only interested in an airplane or missile until it got into production, find themselves huddled in a slit trench or in a concrete blockhouse, watching the firing, seeing at first-hand what there is to go wrong when their ideal designs hit field conditions. They have learned more about engineering and design by doing on missile projects than they ever learned before in aircraft.

▶ Missile Systems—This has been one of the many benefits of the systems contract. The contractor has gotten into the business of supplying vehicles for servicing and transportation, simulators for training, panel displays for education, fire-control points, radar and telemetry stations and test facilities, in addition to his primary responsibility of getting the bird built.

In a typical missile assembly area, two parallel lines feed toward the factory door. Down one of them move the missiles, brightly painted and dolled for easy movement. Down the other roll assorted wheeled trailers and vans, containing power supplies, mazes of checkout gear, servicing and maintenance equipment.

Perhaps more than any other single factor, this dual assembly line symbolizes the multiple tasks and design problems of a contractor with a missile systems contract.

▶ Wheels and Towbars—The fundamental premise of a systems contract is that a complex weapon must have simple management. All the loose ends must be gathered together under one roof, and all the responsibility placed on a single pair of shoulders.

The basic task of the contractor sounds simple. He must provide a weapon system, complete and ready to go.

Under this form of contract, he must assume functional responsibility of propulsion systems, avionic equipment and launchers. The complex test and checkout gear involves his engineers in new facets of human engineering; one unexpected dividend of the systems contract has been new concepts of go no-go checking tech-

niques developed for ease of maintenance and operation in the field.

A large variety of wheeled and towed vehicles have to accompany a missile unit into operations. The missile itself has to be transported, perhaps unassembled, it has to be reassembled, aligned, moved to checking, fueling and arming sites, and finally to its launcher.

The German V-2, operating in wartime with rocket battalions, required a fleet of 32 special vehicles to handle the tasks associated with the simple firing. A typical contemporary missile is supported by 64 different major items, including mobile vehicles and stationary equipment.

▶ **Super-Systems**—But these are only the start. When engineers talk in terms of systems contracts for as vast an undertaking as the Convair Atlas intercontinental ballistics missile, they are talking big.

Atlas originated under a systems concept, glued together under Convair operation. But it now is coming unstuck, with much feeling pro and con. This current situation may well be the turning point in the systems concept.

There has never been a missile like Atlas, and consequently there is no experience in handling a job of that unknown magnitude. Big vehicles have been built before, perhaps the closest approach to an Atlas type systems contract would be producing a Forrestal-class carrier. But most big structures have been based on progressive experience with smaller ones. Atlas is first and has very little to draw on but engineering courage.

▶ **Coming of Age**—With Atlas in the stockpile, the push button war era will have arrived. But it's a long way off and today's one Sparrow does not make an arsenal.

In missiles, then, the military posture is one of transition from the first tentative and exploratory firings to the first combat-simulated use. It's a question now of building the experience that can only come with many field operations, in maneuvers and continuing tests. These have to be backed up with progressive development and research work behind the scenes, feeding in new knowledge five or 10 years ahead of time.

These are the steps that lead to the weapons of tomorrow.

Missile Types

About 30 different missile projects now are aiming toward tangible hardware, with an unknown number of design and development projects behind them. The industry sees an annual billion-dollar mark for the first time since missile development began in the prolific post-World War II period.

Almost every major airframe and avionics manufacturer is in the picture, and the net of subcontractors for manufacturing and suppliers of equipment extends downward through hundreds of small industries.

The specialized technology of missile designs is giving extra employment to small engineering firms specializing in consultation on one particular phase of science, or firms with a group of skilled draftsmen and designers.

Private research institutes and foundations supplant the major effort of government-owned research and test facilities with projects delving just beyond the foreseeable future.

An indication of the magnitude of the current program can be seen in the listing of guided missiles in the Technical Specifications section of this issue.

▶ **Balanced Effort**—Missile projects are about evenly divided between offensive and defensive weapons, with the slight edge going to the offensive job. Heaviest effort is going into surface-to-surface missiles, with anti-aircraft (surface-to-air) a close second.

Big three in the SSM strategic missile category are Convair's Atlas, North American's Navaho, and Northrop's Snark. Chronologically, Snark is a near-operational weapon, Navaho is in the early flight test phase and Atlas is made of the nebulous web of engineering dreams.

All are aimed at intercontinental atomic or hydrogen capability, carrying the lethal load over distances ranging upwards from 4,000 mi.

• **Snark is a subsonic cruise missile**, with a flight altitude comparable to today's jet aircraft which it greatly resembles. Its highly swept, thin wings of high aspect ratio were designed with aerodynamic efficiency as the first consideration. The bulky cylindrical fuselage houses fuel, guidance (reported to be a star tracking navigational system) and the turbojet powerplant fed through an underbelly flush inlet.

• **Navaho is a supersonic cruise missile**, blasted by a rocket motor to cruise at altitudes well above 50,000 ft. Power for flight comes from ramjet engines, capable as a class of operating to Mach numbers approaching 4 and altitudes approaching 100,000 ft. Navaho's engines are working at lower values.

• **Atlas is an intercontinental ballistic missile** (IBM) powered by rocket engines and using multi-stage construction to achieve the terrific speeds and altitudes needed for its range. Peak altitudes may be about 600 miles, top speed up to Mach 15. Problems and possibilities of this kind of missile were outlined in AVIATION WEEK Feb 28, p 26.

• **Nike, in the anti-aircraft field**, has been far and away the most publicized missile. An operational unit since early last year, Nike has been beset by the major problems of localized public relations. The areas that once screamed for air defense are now screaming to get the Nike batteries somewhere else. An unfortunate program of public education, left by default largely in the hands of local politicos, Legion commanders and ROTC professors has done Nike absolutely no good.

It's an interim weapon, and everybody should know that. It is a reliable and accurate weapon within the parameters laid down for its operation. Its killing power is excellent against piston-engined planes, less so against theoretical jets. It is expensive, can be fooled by enemy tactics and countermeasures, but it's there and available.

• **Corporal, a tactical missile** with battlefield range, has gone into service with field artillery units in Europe. Corporal is a rocket-powered development of the Corporal E research rocket designed by the Jet Propulsion Laboratory of California Institute of Technology.

• **Honest John is a less-complex beast** and should not in fact be listed with guided missiles. It most nearly resembles an overgrown bazooka, even to the shape of the rocket body. It is a ballistic rocket of medium range, launched from a simple mobile rail and aimed like an artillery piece. Once it has left the launching rack, there is not further control over its flight.

• **Terrier is the Navy's contemporary bet** for anti-aircraft. Not the least of the Navy worries is the problem of handling and storing what amounts to a 20-ft long artillery shell. Adapting ships for storing, assembling, feeding and firing Terrier missiles taxed Naval architects beyond their usual level of application. The guided missile cruisers about to go into service with the Fleet will be not much more than floating and mobile final assembly lines and launching points.

• **Sparrow has been air-tested** by Marine and Navy units, firing the air-to-air missile against targets and drone aircraft. Though small, a combination of a highly lethal warhead and well developed guidance makes the Sparrow, even in its current interim form, a very formidable piece of airborne ordnance.

Summing up the past year of missile progress can be done simply with a single word: Transition. There are, of course, the tremendous implications that are seen as we swing more and more toward the weapons of the future.

If we had to go to war tomorrow, this half-dozen would represent the payoff on a five-billion investment. Next year will be even better.

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for tomorrow's even greater supersonic speeds

● AIR TRANSPORT

The air transport industry is suffering its final growing pains with the prospect that this year will bring coming-of-age adjustments. Vast growth prospects are ahead for this billion-dollar business. But each segment suddenly has outgrown the management, financial, equipment and regulatory policies under which they have operated.

Domestic and international carriers, pinched by rising costs, narrower profits and decreasing attraction for fresh capital, will streamline business methods and seek higher fares. Local airlines expect permanent certificates to end their insecurity but they will still need a low-cost feeder plane. Nonskeds see better prospects for permanent certification.

VICKERS VISCOUNT

● AIR TRANSPORT

Trunks Head for New Records, Problems

By Preble Staver

The U.S. air transport industry was a healthy giant during 1954. The past year saw one segment of commercial air transportation--the 13 scheduled trunk airlines--approach $1 billion gross revenue.

Backbone of the industry, the domestic trunklines, in 1954 established record highs in all but one type of traffic. Total revenues were $982,750,000, a gain of 12% over the preceding year.

Industry and government leaders predict a continued growth in 1955 with record volumes of air passengers, mail and cargo exceeding the impressive marks set in 1954.

Reasons for trunklines' favorable year:

- **Continued increase** in the volume of air travel.
- **Financial outlook** that was good on the whole.
- **No dependence on government subsidy** except for three or four individual carriers.

In keeping with the almost phenomenal traffic growth, there was a continuing accent on safety, resulting in one of the best safety records achieved by the U.S. scheduled airlines--.08 fatalities per 100 million passenger-miles.

This figure compared with .60 in 1953 and .38 in 1952, the previous record year.

► **New Records**--Here are some of the records compiled by the trunk airlines during 1954:

- **Passengers**, as usual, constituted the bulk of the traffic and revenues. Approximately 29.5 million passengers were flown over 16 billion passenger miles, and earned for the carriers $875,000,000 in revenues. These were new passenger records.
- **Coach passenger traffic** accounted for 33% of the total domestic trunkline travel, another new record. The significant increases in air travel were directly attributable to the continued development of aircoach services.
- **Mail ton-miles** showed an increase of 12% for a total of 80,176,000, mail revenues of $38,925,000 were up less than 7%. Mail yielded just 5% of total revenues. Airmail was carried at 48.59 cents per mail ton-mile.
- **Air express** was the only service to show a decrease. The 40,090,000 ton-miles flown was 10% below the 1953 figure. Gross revenue from air express was $15 million.
- **Airfreight** flown totaled 144,242,000 ton-miles and produced revenues of $32 million for gains of 9.5% and 12%, respectively, over the preceding year.
- **Total revenue ton-miles** showed a 12% increase over last year's 1.6 billion. The yield per ton mile dropped slightly, however, from 53.66 cents in 1953 to 53.24 cents in 1954.

► **Profit Squeeze**--Only dark spot on the otherwise bright horizon for these air carriers is the more rapid climb of expenses compared with revenues. Total expenses increased 14%, to a new high of $895,200,000. It meant that operating income of approximately $87.5 million was about 5% less than the year before. Shrinking profit margin remains a major problem for the group, as operating income has declined steadily since the record of $106 million was reached in 1951, dropping to $95 million in 1952 and down to $88 million in 1953.

Problem of financial stability is compounded by the need for fresh capital to finance expansion and the failure to win the confidence of the investing public. There is no question the industry's inability to realize adequate earnings is the big drawback in its efforts to attract the independent investor. This is but one of several fundamental problems requiring the constant attention of airline officials to maintain a healthy business.

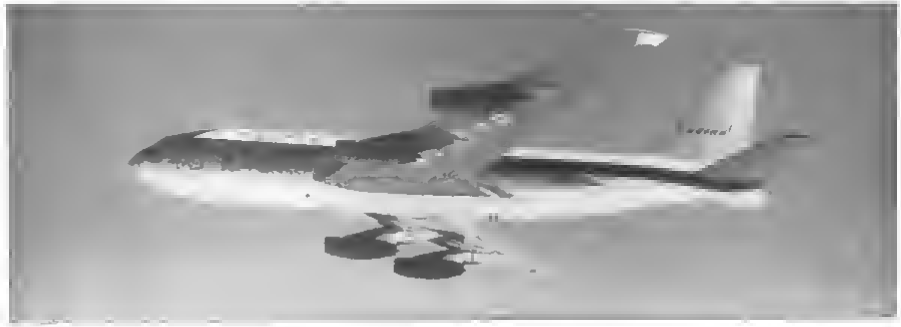
An extremely active year ahead is the forecast--a highly competitive year in which the trunklines will be offering increased space for both passengers and cargo. Thus, the air traveling and shipping public should be getting more and better service than ever before in air transporation history.

► **Need for Higher Fares**--Airline officials are looking forward to the immediate future optimistically, and on a longrange basis they see the current year-to-year growth trend continuing for another decade. More than one company hopes that it will be possible to hold unit costs at approximately the same level as in 1954, but an upward adjustment of fares would seem to be in the cards.

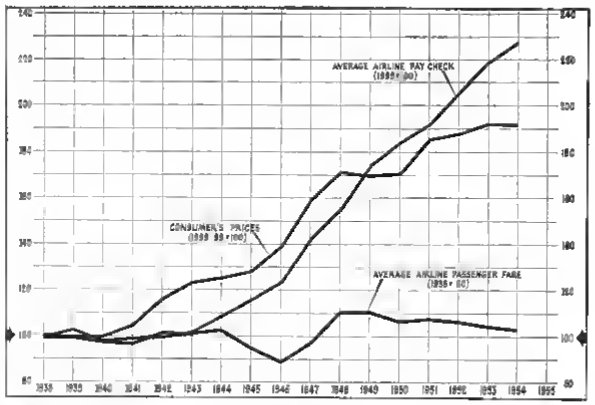
The usual traffic slump of the first quarter was revised in 1955 and business for the months of January, February and March was running well ahead of the comparable period last year. However, the 1955 first quarter was not looking much better as far as profits were concerned. The trend of narrowing profit margin is the trunk carrier's

LOCKHEED SUPER CONSTELLATION

DOUGLAS DC-7



BOEING 707



biggest argument for a fare increase.

General industry feeling is that the airline fare level has been static too long, that increased fares become necessary to help offset the narrowing profit margin under which they have been operating. A complete lack of sympathy, so far, on the part of the Civil Aeronautics Board has forestalled solving the problem of reduced profits. If the fare level problem can be settled, it is believed there is no limit to the growth of the industry's trunkline segment.

▶**More by Air**—The increased acceptance of air transportation for travel is best exemplified by the air carrier's penetration of the passenger traffic market. Although the total number of passengers using common carriers has declined, particularly since World War II, the number using airlines has increased. This trend continued in 1954. There was a gain of some 12% in passenger traffic for the domestic trunk and local-service airlines, whereas the rail coach and Pullman traffic was off about 9% and a loss of 12% is indicated for intercity bus traffic.

Distribution of the intercity passenger business among the three major types of common carriers in 1954 was: domestic airlines, 28.9%; bus, 30.5%, and rail, 40.6%. The airlines' share in the market has been increasing for both first-class and coach services. First-class airline passenger traffic growth didn't match the first-class rail until 1952, since then it has pulled steadily away, to where, in 1954, the number of passengers carried by the airlines was twice that of the rails.

In 1954, for the first time in history, an air carrier reported a greater total of intercity passenger miles than any railroad in the U. S.

American Airlines' total, for the first six months, of 1,746,060,000 passenger-miles took the long-held leadership from the Pennsylvania Railroad for the period. However, the adverse effect of

Domestic Trunklines—Traffic, Revenue and Expenses, 1953-1954

Item	1954	1953	Percent Change
Traffic			
Revenue Passengers	29,413,000	26,137,000	12.53
Revenue Passenger Miles	16,233,000,000	14,298,000,000	13.53
Mail Ton Miles	80,176,000	71,726,000	11.78
Express Ton-Miles	40,090,000	42,515,000	−5.70
Freight Ton-Miles	144,242,000	131,779,000	9.46
Total Revenue Ton-Miles	1,847,855,000	1,637,451,000	12.85
Revenue			
Passenger	$875,500,000	$775,782,000	12.99
Mail	38,925,000	36,453,000	6.87
Express	15,001,000	16,830,000	−10.86
Freight	32,225,000	29,341,000	9.83
Total Revenues	982,750,000	878,793,000	11.95
Expenses, Total	895,200,000	790,716,000	14.07
Operating Income	87,550,000	88,077,000	−5.4

Aircoach Statistics—1954 and 1953

Carrier	Passengers		Passenger-Miles		Revenues	
	1954	1953	1954	1953	1954 Est	1953
American	610,176	368,082	754,500,000	562,526,000	$30,935,000	$23,049,262
Braniff [1]	29,980	2,732	16,296,000	1,561,000	668,000	62,128
Capital	331,629	266,047	146,851,000	131,742,000	6,021,000	5,640,915
Colonial	27,005	39,607	8,177,000	11,555,000	335,000	493,108
Delta C&S	228,333	139,440	165,378,000	108,987,000	6,781 000	4,513,554
Eastern	1,030,206	714,045	872,801,000	649,692,000	35,785,000	26,957,928
National	420,566	309,544	392,281,000	303,090,000	16,084,000	12,273,676
Northwest	322,894	310,419	293,750,000	291,759 000	14,099,000	13,939,702
TWA	1,078,773	790,051	1,370,908,000	1,027,702 000	56,207,000	39,524,125
United	869,108	574,751	847,225,000	535,256 000	34,736,000	22,667,954
Western	295,126	218,899	148 844,000	102 201,000	6,103,000	4,260,738
Totals	**5,243,796**	**3,663,617**	**5,017,011,000**	**3,726,071,000**	**$207,754,000**	**$153,383,090**

[1] Braniff inaugurated coach service Dec. 4, 1953.
Source: CAB reports

the 24-day pilot strike on American in August, returned a tenuous lead to Pennsylvania for the year. It is not surprising to note that of the 10 top common carriers in 1954, four were trunk airlines — American, United, Eastern and TWA. The Big Four are surpassed as major transporters of passengers by only two railroads.

▶ **Aircoach Up**—All of the domestic trunklines, except Continental and Northeast, offer aircoach service, the biggest single traffic growth factor.

Aircoach's lower fares, comparable to rail fares, sparked immediate and enthusiastic reception by the traveling public, this accounts for a growing percentage of total traffic.

Coach traffic was 33% of the passenger-miles in 1954 and promises to reach better than 50% this year. Practically all operators are expanding their aircoach service, yet how far to go has become of increasing concern in the industry.

Coach fares now stand roughly at 4¼ cents per mile, with the average first class passenger fare at about 6 cents per mile. Thus, coach traffic has a definite bearing on profits. While passenger traffic advances, the tremendous growth of coach services is rapidly diluting the potential gains in passenger revenues.

▶ **Mail Moves by Air**—The trunk airlines carried more mail during 1954 than in any other year since the service began in 1926. It was also the first full year of the Post Office experiment of flying 3-cent regular mail on a space-available, subsidy free basis.

A total of 21 air carriers—seven trunklines and 14 local service airlines—were authorized to participate in the new service. On an annual basis, ap-

Airlines Take Bigger Share of Travel Market

Intercity Revenue Passenger Miles by Type of Carrier and Class of Service
(In Millions)

	1954		1953		1952	
	Amount	Percent of Total	Amount	Percent of Total	Amount	Percent of Total
Airline						
First Class	11,200	19 6	10,962	18 0	10,105	16 1
Coach	5,300	9 3	3,726	6 1	2,356	3 7
Total	16,500	28 9	14 688	24 1	12,461	19 8
Railroad						
First Class	6,500	11.4	7,950	13 1	9,504	15 1
Coach	16,500	28.9	18,955	31 2	19,758	31 5
Total	23,000	40 3	26,905	44 3	29,262	46.6
Motor Bus	17,600	30 8	19,253	31 6	21,118	33 6
Total Common Carrier	57,000	100 0	60,846	100 0	62,841	100 0

Sources: CAB Annual Airline Statistics and Recurrent Reports of Traffic, ICC Statistics of Railways in the U S and Annual Reports

Leadership in Intercity Passenger Traffic

Comparison of Air & Rail Revenue Passenger-Miles: 1954 & 1953
(Domestic, Excluding Commutation)

1954		1953	
1. Pennsylvania RR	3,447,433,432	1 Pennsylvania RR	3,859,827,000
2 American Airlines	3,371,860,000	2 New York Central	3,256,924,000
3 United Air Lines	3,134,568,000	3 American Airlines	3,210,483,000
4 New York Central	3,041,251,121	4 United Air Lines	2,547,616,000
5 Eastern Air Lines	2,847,082,000	5 Trans World Airlines	2,370,019,000
6. Trans World Airlines	2,611,014,000	6 Eastern Air Lines	2,309,267,000
7 Atchison, Topeka & Santa Fe	1,948,256,639	7 Atchison, Topeka & Santa Fe	2,084,991,000
8 Union Pacific	1,459,288,247	8 Union Pacific	1,562,489,000
9 Southern Pacific	1,341,782,010	9 Southern Pacific	1,500,102,000
10 N Y, N H & Hartford	1,273,558,125	10 N Y, N H & Hartford	1,356,484,000

U. S. Aircraft Engaged in Air Transportation

SCHEDULED AIR CARRIERS, DOMESTIC SERVICE

Cert. No.	OPERATOR	Douglas DC-7	DC-6	DC-6A	DC-6B	DC-4	DC-3	Lockheed 1049	749	649	049	14	Martin 404	202	Boeing 377	Convair 340	240	Curtiss C-46	Helicopter S-51	S-55	47D	Total
	TRUNKS & FEEDERS																					
105	Allegheny Airlines						14															14
25	American Airlines	25	50	5	25	8											74					188
804	Bonanza Air Lines						5															5
18	Braniff Airways		6			2	24									23						58
21	Capital Airlines					25	21		7		5											58
404	Central Airlines						8															8
23	Colonial Airlines					5	8															13
14	Continental Airlines				2		9									6						17
28	Delta Airlines	7	7				16			3						30						63
14	Eastern Air Lines					11		20	18				60									110
206	Frontier Airlines						12															12
200	Lake Central Airlines						7															7
104	Mohawk Airlines						10															10
16	National Airlines	4	4		8							11				12						39
303	North Central Airlines						18															18
18	Northeast Airlines						12										7					19
20	Northwest Airlines			5		19	8								10							42
303	Ozark Airlines						12															12
208	Piedmont Airlines						15															15
33	Pioneer Air Lines						11							9								20
209	Southern Airways						10															10
601	Southwest Airways						10							4								14
401	Trans-Texas Airways						16															16
17	T.W.A. (Domestic)					12		10	36		32		40	12								142
11	United Air Lines	25	43		21	20	18								1	55						183
702	West Coast Airlines						12															12
25	Western Airlines				8	6	5										9					33
	TOTAL	61	113	8	84	109	285	39	62	3	37	11	100	25	11	118	95	0	0	0	0	1,134
	HELICOPTERS																					
304	Helicopter Air Service																				6	6
306	Los Angeles Airways																		3	4		7
104	Mohawk Airlines																			1		1
16	National Airlines																			1		1
107	New York Airways																			3		3
	CARGO ONLY																					
203	Aerovias Sud Americana																	5				5
208	Flying Tiger Line			2		7												25				34
212	Riddle Airlines																	5				5
200	Slick Airways, Inc.			2														13				15
201	U S Airlines																	0				0
	INTRASTATE																					
6-4	(C) California Cent Air						2							4								6
6-6	(C) Friedkin Aeronautics, Inc.						4															4
FW-3	(C) Texas Central Airlines						2															2
	TOTAL	0	0	4	0	7	8	0	0	0	0	0	0	4	0	0	0	51	3	11	6	94
	Acft. Listed on Trunk & Feeder Certs.	61	113	8	84	109	283	39	62	3	37	11	100	25	11	118	92	0	0	0	0	1,134
	Acft. listed on Helicopters, Cargo Only & Intrastate Certs.	0	0	4	0	7	8	0	0	0	0	0	0	4	0	0	0	51	3	11	6	94
	Acft. listed on all Domestic Certificates	61	113	12	84	116	291	39	62	3	37	11	100	29	11	118	92	51	3	11	6	1,228

proximately 20,000 tons of 3-cent surface mail is being handled by the domestic airlines

For the Post Office Department, the result is low-cost transportation and the public is being saved billions of hours of delivery time. The only opposition to the Post Office experiment, which may stem from a fear of an eventual "all-up" mail program, has come from the railroads. Litigation instituted by the rails against the Post Office on the charge that the experiment is illegal should be decided by the courts this year.

There is also the prospect of a further reduction in the trunkline's service mail rates paid by the Post Office in the immediate future. Because of the PO's threat to offer airmail only to the lowest rated carrier where two or more carriers operate between the same pair of points, CAB reopened the mail rates for all 13 domestic trunks in the spring of 1954.

The Board's solution was to propose, for the first time, a uniform multi-element service mail rate, which provided equal payments for all carriers serving any given pair of points. The proposal to establish the final rates for each of the 13 carriers was made in September, but is not yet settled because of objections by various parties.

▶ **Military Movements**—A relatively new and increasingly important category of traffic has been domestic military movements by air. Potentially the largest single market for the airlines, the scheduled airlines' share of the military travel budget rose from 2.3% or $4.8 million in fiscal year 1950 to nearly 10% or $41 million in fiscal 1955.

Acceptance of air transportation by the military is noticeable from the steady trend of conversion from surface to air, and a permanent market seems assured. Military transport officials have increased the use of air carriers for even the routine transfer of personnel from one installation to another, on the basis of lower costs primarily. Other factors: efficiency, service and speed.

▶ **New Equipment**—The trunklines met the 1954 traffic growth with an expanding capacity in the integration of new equipment. Labor relations in 1954 were from good to excellent in the overall picture. There was the usual cooperation with the government regulatory agencies, CAA and CAB. As far as any changes in the existing statutes governing civil aviation, Congress stood pat.

The new equipment highlight of the year was introduction of the DC-7, the latest and largest of a series of Douglas-built four-engine piston transports. During the year, nearly 50 of these 365-mph aircraft were delivered to trunk carriers. The DC-7 and Lock-

Comparative Direct Operating Costs for U. S. Transports

(Cents per U S domestic plane-mile, 9 months ending Sept 30)

	1953				1954			
	Flying Operations	Direct Maintenance	Depreciation Charges	Total Direct Operating Costs	Flying Operations	Direct Maintenance	Depreciation Charges	Total Direct Operating Costs
DC-3	31 57	11 10	2 62	45 69	28 71	11 25	3 24	43 20
DC-4	45 82	18 89	4 25	69 69	45 81	20 97	3 60	69 06
CV 240	41 23	24 97	11 80	77 80	41 92	24 97	15 39	80 28
CV-340	44 36	14 99	20 13	79 38	41 82	15 73	18 31	76 86
MARTIN 4-0-4	43 18	16 36	20 84	80 38	42 75	18 05	22 85	83 66
DC-6	52 15	21 03	18 17	89 35	55 07	15 35	15 88	83 90
DC-6B	56 52	18 10	23 45	97 27	55 18	18 49	18 51	92 58
L-749	51 30	27 18	15 19	103 71	51 58	25 48	13 92	100 85
L-1049	74 09	31 80	41 42	146 81	67 13	23 88	37 17	134 49
B-377	84 80	40 00	36 62	170 27	82 95	41 00	43 53	185 17
DC-7					56 70	20 81	32 84	131 35

Source: Airline Finance and Accounting Conference.

heed Super Constellation marked new milestones in coast-to-coast travel with the inauguration of 2,500-mi non stop services by the transcontinental airlines.

Other major equipment developments included the initial flight and service tests of a prototype jet transport by Boeing. Designed and built for use as either a military aerial tanker or commercial passenger transport, the Boeing 707 is the first U S. challenge to the British for the world jet market.

Other major U S aircraft manufacturers have jet designs in various stages.

▶ **Turboprops First?**—However, a large segment of the industry advocates an orderly transition to jet transports from piston engine planes via turboprop aircraft. This is particularly true in the short-haul passenger field and will be tested by Capital Airlines with a British import, the Vickers Viscount. A firm order for 60 of the Viscounts was placed by CAP in 1954, with delivery of the first plane scheduled next month.

Other equipment and technological advances of the year included greater use of electronic flight simulators. United Air Lines was the first domestic carrier to install simulators. Several companies are placing orders for airborne radar.

▶ **Labor**—Considering the number of potential labor-trouble exposures with total employment in excess of 100,000 and 20 unions represented, the airline industry got along surprisingly well in 1954. There were a total of 225 labor agreements in effect and a large percentage of them were negotiated during the year. The national Mediation Board disposed of a total of 103 airline cases, of which 79 were mediation cases and 24 were representation disputes.

The one major strike to hit the trunklines was a walkout of American Airlines' pilots for 24 days in August. The 1,200 pilots struck as a result of American's scheduling transcontinental non stop flights in excess of eight hours, as permitted by amended CAB regulations. The case went to arbitration and the pilots returned to work pending a final decision.

Still pending at the end of the year was a threatened strike by 20,000 members of the AFL-International Association of Machinists against six trunk carriers—Capital, Eastern, National, Northwest, TWA and United. A twice-extended Presidential emergency board is keeping the men on the job to date.

▶ **Regulation**—Route cases, mail rates and mergers continued to occupy CAB and the carriers during the year. For the first time in 12 months there were no trunkline mergers, although CAB approved the acquisition of Pioneer Air

Distribution of Military Passenger Traffic

U. S. Domestic Common Carrier Services
(Organized Movements of 15 Men or More)

	FY 1954		FY 1953		FY 1952	
	PSGR-Miles	Percent of Total	PSGR-Miles	Percent of Total	PSGR-Miles	Percent of Total
Air	531,833,000	42 86	598,022,000	34 91	391,426,000	18 86
Bus	101,226,000	8 16	132,359,000	7 72	94,009,000	4 53
Rail	607,770,000	48 98	982,861,000	57 37	1,589,605,000	76 61
Total	1,240,829,000	100	1,713,242,000	100	2,075,040,000	100

Subsidy Estimates for Operations—Fiscal Years 1953-1956

	(In Thousands)				
	1952	1953	1954	1955	1956
Domestic Trunks	$6,411	53,527	$3,813	$4,908	$4,517
Local Service	19,033	21,619	24,632	25,035	25,135
Helicopters			2,570	2,685	2,928
States-Alaska	2,075	3,226	3,391	3,606	3,549
Intra-Alaska	3,349	4,639	4,951	4,650	4,523
Hawaii	715	945	1,154	719	718
Trans-Atlantic	10,063	8,898	3,984	2,567	2,669
Trans-Pacific	11,641	12,173	11,640	5,457	1,483
Latin-American	14,511	16,214	16,917	16,524	16,176
TOTAL	$67,798	$71,241	$73,052	$66,151	$61,698

Domestic Trunk and Local-Service Airlines

Average Passenger Revenue—Cents per Mile

	First Class	Aircoach	Total
1954	5 90	4 15	5 36
1953	5 88	4 13	5 44
1952	5 87	4 16	5 55
1951	5 76	4 47	5 59
1950	5 74	4 17	5 54
1949	5 81	3 98	5 76
1948	5 74		5 74
1947	5 03		5 03
1946	4 62		4 62

Source: CAB Annual Airline Statistics and Recurrent Traffic Reports

Lines, a local-service carrier, by Continental Air Lines. The Board still has pending the proposed merger between Eastern Air Lines and Colonial Airlines after the President rejected CAB's initial approval. Exercise of prior control by Eastern over Colonial has been at issue with the whole deal bitterly contested by National Airlines which wants to merge with Colonial.

Continued efforts to obtain a U. S.-Mexico bi-lateral air agreement were fruitless, but there was a flareup over New York-Mexico City nonstop rights, with a running battle between American Airlines, Eastern Air Lines and Pan American World Airways.

Other major route cases in process included additional New York-Florida service, a nine-year-old case in which a dozen carriers are fighting for one of the top traffic plums in the domestic route system, the New York-Chicago case; Denver Service case, and additional service between the Southwest and the Northeast.

►**Legislation**—In 1954, the air transport industry was faced with a concerted effort in the Senate to rewrite the Civil Aeronautics Act of 1938. Result of the extensive review of the basic civil aviation law conducted by the Senate Interstate and Foreign Commerce Committee was a conclusion that the 1938 act is sound but needs to be updated.

Already this year numerous proposals have been made for some rather substantial amendments to the act and the industry is set to face some changes.

Load Factors

Average Passenger Load Factors of the 13 Certificated Scheduled Trunk Airlines for 1954 Compared with 1953

	1954	1953
American	68 11	67 78
Braniff	62 48	56 37
Capital	58 69	58 99
Colonial	58 46	57 40
Continental	54 31	51 54
Delta-C&S	60 07	61 50
Eastern	58 48	60 21
National	59 58	66.54
Northeast	55 92	55.33
Northwest	60 34	59 83
Trans World	68 11	70.76
United	65 99	68 36
Western	55 77	58 54
TOTAL	60 02	61.01

Source: CAB Annual Airline Statistics and Recurrent Traffic Reports.

LOCKHEED SUPER CONSTELLATION

Report on U. S.-Flag Airlines . . .

Revenue Goes Up, Subsidy Starts Down

By Craig Lewis

Continued gains in business and a surprising improvement in the subsidy situation are highlights of U. S. international carrier operation during 1954. Industry leaders predict further gains this year.

United States-flag carriers showed gains in both revenues and traffic, and subsidy estimates indicate that the international lines have turned the corner in the fight to reduce subsidy. The trend is definitely downward.

Last year, overseas operators had total revenues of $365,250,000 compared with $337,286,000 in 1953. Total expenses were up, too, but not as much as revenues. Expenses in 1954 were $325,750,000, up from $317,907,000 in 1953.

Traffic totals show a gain of about 10%. Revenue ton-miles amounted to 512,405,000 in 1954 and 466,774,000 in 1953.

Here is how traffic and revenues break down by category:

- **International** lines carried 2,849,000 passengers 3,743,000,000 revenue passenger-miles in 1954. Passenger revenue came to $256,021,000. This compares with 2,682,000 passengers, 3,381,000,000 revenue passenger-miles and $232,539,000 in passenger revenues for 1953.
- **The U. S.-flag carriers** flew 35,312,000 ton-miles of U. S. mail and 7,337,000 ton-miles of foreign mail, with revenues of $59,055,000 for U. S. and $9,535,000 for foreign mail. Ton-miles of U. S. and foreign mail in 1953 were 24,468,000 and 6,371,000 respectively, and revenues were $53,747,000 and $9,556,000.
- **Cargo** traffic amounted to 82,102,000 ton-miles, an increase of about 10% over 1953. Revenues were $29,458,000.

These figures indicate traffic gains of about 10% and revenue gains of about 8%. While there has been some concern in the industry over narrowing profit margins, this condition seems to have eased off somewhat by the end of the year.

One of the biggest gains made by the airlines in 1954 is one that hasn't yet been fully realized by the industry. Subsidies, which only six months ago were supposed to remain the same or go higher, have suddenly been found to be dipping, and by considerable margins. The major factor in these subsidy decreases has been the international air carriers.

▶ **Reappraisal**—Last month, Civil Aeronautics Board re-examined the subsidy estimates it had published last September. In September, CAB figured total subsidy would run $80,448,000 in fiscal 1954, $79,426,000 in 1955 and $79,100,000 in 1956. The reappraisal shows that subsidy for these years now can be estimated at $73,052,000 for 1954, $66,151,000 for 1955 and $61,698,000 for 1956.

Thus, in six months, subsidies have dropped from estimates to the extent of $13,275,000 for the current fiscal year and $17,402,000 for the coming year. This trend is attributable almost entirely to the international carrier, since subsidy trends in other categories are actually still going upward.

Atlantic and Pacific operations are the areas in which the gains have been made. In 1952, the last year TWA was on subsidy, the figure for trans-Atlantic operations was $10,063,000. In fiscal 1955 it is estimated at $2,567,000. In the Pacific, the fiscal 1952 subsidy was

in mass production by Norden-Ketay

ers are used with Nor-
ro torque transmitters
ating systems Accura-
ee or better are avail-
400 cycle units, and in
37

VERS

Function	Voltage Rating (VAC)	Receiver Error (Maximum)
Receiver	26/11.8	±1½°
Receiver	115/90	±1.0
Receiver	26 11.8	±1.0°
Receiver	115 90	±1.0
Receiver	115 90	±1.0
Receiver	115 90	±1.0
Receiver	115 90	±1.0°
Receiver	115 90	1.5°
Receiver	115 90	±1.0°
Receiver	115 90	±1.0°
Receiver	115 90	±1.0°
Differential Receiver	90 90	1.0°
Differential Receiver	90 90	(1)
Receiver	115 90	±0.8°
Differential Receiver	90 90	±0.8°
Receiver	115 90	±0.8°

t, Sensitivity 10

ay Induction Motors
in sizes 18, 20, and 23
ree phase, 2 pole, 2
e, and 3 phase, 2 pole
0 cycle operations are

TORS

Operating Voltage	Minimum No Load Speed (RPM)	Minimum Stall Torque (oz. in.)
3 Phase 115 V	3300	3
2 Phase 115 40	1500	2.7
3 Phase 115 V	3400	1.6

tachometer generators for 60 and 400
linearity of 0.1% are available in pro-
eed voltages are held to 5 millivolts in
re, and 15 millivolts third harmonic

rvo motor driven tachometer generators
ounted gear trains Built for extreme am
nits assure dependability and long life
daptations can generally be supplied

ER-GENERATORS

corresponding motors as indicated

Linearity (with respect to voltage)	Maximum Speed for Linear Output	Rotor Moment of Inertia
1%	4500	5.26 GM CM.
1%	4500	5.36 GM CM.
1%	4500	5.26 GM CM.
1%	4500	5.26 GM CM.
1%	4500	5.73 GM CM.
1%	4500	5.73 GM CM.

(1) K02400 5 (2) R41560 (3) R40256 (4) R40755

hess, with maximum thickness as little or
for applications where minimum thickness
ffi. Control transmitters, control trans
s are available

HRO

Input Current	Input Power	Output Voltage	Angular Accuracy
155 Ma	21 W	11.8 V	30
80 Ma	10 W	11.8 V	30 0.4 V/Deg
98 Ma	5.1 W	90 V	20
6 Ma		60 V	20'

Used with Norden Ketay synchro control transmitters in closed cycle servo systems, Norden-Ketay synchro control transformers develop a voltage gradient of one volt per degree of system error They are available with null voltages as low as 60 millivolts total and 30 millivolts fundamental and with accuracies as great as 6 min in standard models which match Norden Ketay synchro control transmitters

SYNCHRO CONTROL TRANSFORMERS

Type No	Govt Designation	Frame Size	Frequency	Voltage Rating	Electrical Accuracy Max Error
K101560		10	400	26 11.8	30 SPD
K101530		10	400	12 11.8	24 SPD
101A2C		11	400	11.8 0.4 V per deg	20 SPD
101A25	11CT4e	11	400	90 1 V per deg	7
105A2A	15CT4e	15	400	90 1 V per deg	10'
K101300		15	400	26 11.8	90 SPD
K101750		15	400	11.8 22	15 SPD
K101300-20		15	400	10.2 26	17 SPD
106L2A	16CT84e	16	400	90 1 V per deg	±10'
(1) K402100		17	400	12.4 10 V per deg	
108A1A	18CT6e	18	60	90 1 V per deg	8'
108A38	18CT4e	18	400	90 1 V per deg	8
109L2A	19CT84e	19	400	90 1 V per deg	±8
109L18	19CT86e	19	60	90/1 V per deg	±8
112A1A	1 HCT	(3)	60	90 1 V per deg	±18
113A28	23CT4e	23	400	90/1 V per deg	±6'
113A1A	23CT6e	23	60	90 1 V per deg	±6'

(1) Linear Synchro

(1) High Impedance unit
(2) Linear synchro
(3) When used as control transmitter 26/11 8 VAC

Norden-Ketay Resolvers from Coarse ±0.2% to Precision ±0.05% for use in computers, radar sweep circuits, phase shift ers, and accurate data transmission systems

SYNCHRO RESOLVERS

Type No	Govt Designation	Frame Size	Frequency	Total Null Voltage Max. at Test Voltage	Test Voltage	Input Impedance Ohms	Voltage Rating (VAC)	Angular Distance Between Null Voltage	Maximum Angular Accuracy
(1) K101590		10	400	200 MV	26 12	2380 67.7°	26/11.8	90 5	30 SPD
K101580-5		10	400	60 MV	26	560 62°	26/11.8		30' SPD
101D2A		11	400	60 MV	26	1510/73°	26/22	90 15	±10
101D3C		11	400	60 MV	26	440 76°	26/11.8	90 15	10'
105D2C	15RS4L	15	400	25 MV	26	585 81°	26/11.8	90° 10'	20 SPD
K101450		15	400	50 MV	26	2000 72.5°	26/18	90° 10'	40 SPD
K101340		15	400	60 MV	26/12	465 61.3°	26/11.6	90° 4'	20 SPD
(2) 105D2A2		15	400	10 MV	10	3300 82.1°	90/90	90 5'	0.1%
(2) 105D2K1	MK 4 MOD O	15	400	15 MV	15	850 78	26 26	90 5'	0.1%
(2) 105D2K2		15	400	15 MV	15	850 78	26/26	90° 5	0.15%
(2) 105D2K3		15	400	23 MV	15	890 78°	26/26	90° 5	0.20%
(2) 105D10		15	1000 (Test)	30 MV	24	(4) 24.6 mh	0-90	90° 5	0.2%
105D2Z		15	400	40 MV	26	950 82	26/26	90° ±20'	20'
105D95		15	400	75 MV	60	15,000 (Tuned)	60 50	90° 5	±0.15%
113D15	23RS6A	23	60	30 MV	24	570 79°	45/45	90° 5	±.2%
113D3G	23RS4A	23	400	60 MV	60	234 83°	90 90	90 5'	±.2%
113D1D	23RS6	23	60	60 MV	60	685 61°	90 90	90 5'	±.2%
113D25	23RS4	23	400	60 MV	60	720 80°	90/90	90 5'	.2%
113D3T1		23	400	16 MV	8	975 86° @ 10V	8 16	90 5'	±8
113D3T2		23	400	20 MV	8	975 86 @ 10V	8 16	90° 7	±15'
113D3S1		23	350	30 MV	30	3200 86	30 30	90° 5	±8
113D3S2		23	360	30 MV	30	3200 86	30 30	90 5	±8'
113D3S3		23	350	60 MV	90	3200 86	30 30	90 7'	±15'
(3) 113D2P1		23	500	60 MV	50	7000	50 50	90 5'	±5
(3) 113D2P2		23	500	60 MV	60	7000	50/50	90 ±5	10'
(2) 113D2R1	23RS4D	23	400	30 MV	60	3200 86	90/90	90° 2.5'	0.05%
(2) 113D2R2		23	400	60 MV	60	3200 86°	90 90	90° 5	±0.10%
113D18	23RS65	23	60	30 MV	24	480 78°	24/24	90° ±5	±.2%
113D31		23	350	30 MV	30	3780 85.7°	30 30	90° ±5	±0.18%
(2) 113D1N		23	60	76 MV	26	1140 76.3°	26/26	90 ±5	±0.1%
(2) 113D1H		23	1,000 (Test)	30 MV	24	(4) 16.25 mh	0-30 V	90° ±5'	.2%
113D1Q1	33RS68	23	60	13 MV	26	1020/81.6°	26/26	90° ±2.5'	±1%
113D1Q3		23	60	26 MV	26	1020 81.6°	26/26	90 5	15%
113D2A	23RS48	23	400	20 MV	26	550 86°	26/26	90 5'	±10%
113D3C	23RS4C	23	400	30 MV	60	3200 86	90/90	90 ±5	±10%
105D2F	D-13310	15	400	30 MV	26	740 80°	26/26	90 ±5	±10%

(1) High impedance unit
(2) Feedback Resolver
(3) Geared housing

(4) For these Sweep Resolvers input impedance is not considered Instead, inductance at 1000 c.p.s is important.

Inductance at 1000 c.p.s	113D8H	105D8D
Rotor winding	17.7 Mh	27 Mh
Main Stator winding	16.2 Mh	24.6 Mh
Feedback Stator winding	16.2 Mh	24.6 Mh

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United States Aircraft Engaged in Air Transportation

SCHEDULED AIR CARRIER, INTERNATIONAL SERVICE

Cert. No.	Operator	Douglas						Lockheed						Boeing	Convair		Curtiss	Miscellaneous			
		DC-7	DC-6	DC-6A	DC-6B	DC-4	DC-3	1049	749	649	649	18	80	377	340	240	C-46	G44	G21A	Misc.	Total [1]
80E	Alaska Airlines					2	3										***1				6
808	Alaska Coastal Airlines												1					2	6	3	12
30	American Airlines	*25	*50	*3	*25	*9										*78					188
402F	Braniff Airways		*9																		9
3E	Caribbean Atl. Airlines						3														3
102F	Colonial Airlines					*5	*8														13
808	Cordova Airlines						2														2
202F	Delta Air Lines	*7	*7				*16			*3					*20						53
201F	Eastern Airlines					*11		*20	*10												59
803	Ellis Airlines																		7		7
8	Hawaiian Airlines						10								5						15
1008F	Mackey Air Transport						4														4
1002F	Midel Aviation Corp.						1														1
203F	National Airlines	*4	*4		*8						*11				*12						39
301	Northern Cons. Airlines						3													1	4
301F	Northwest Airlines			*5		*18								*10							33
801	Pacific Northern Airlines					4	4														8
8	Panagra		5	4	4	3	6														22
1	PAWA-AD			3(c)	43(c)	22(b)	2				9(a)			(c)							79
44E	PAWA LAD			(c)	(c)	(b)	8				(a)			10(c)		10					28
2&3	PAWA-PAD				3	6					(a)			IT (Cert. 3)							28
808	Reeve Aleutian Airways						3													1	4
211	Resort Air Lines					*2											**6				8
901	Trans. Pacific Airlines						6														6
24	T.W.A. (Intercontinent.)					*2			*27 (d)												29
20CF	United Air Lines	*5	*6																		11
809	Wien Alaska Airlines						2										2				5
In International Service TOTAL		41	81	15	83	84	80	20	46	8	9	11	1	37	37	88	8	2	13	5	572

* Also listed on Domestic Certificate.
** Operated in accordance with Provisions Special CAR No. SR-372A.
*** Operated in accordance with CAR No. 3PI-305A.
[1] Includes 1, CH300; 1 RC3-2, PBY and 1, S-43.

(a) Listed on Certificates 1, 3 and 6.
(b) DC-4s shown on Certificate 1 are also operated on Cert. 6.
(c) S-377s shown on Certificate 6 are listed on 1.
(d) 8 additional L-749s shown on Domestic Cert. No. 17.
(e) Same aircraft listed on Certificates 1 & 6.

$11,641,000, this year's estimate is $5,457,000 and CAB figures that in fiscal 1956 only $1,483,000 will be needed and that Pan American's Pacific operations will be off subsidy.

▶**Military Mail**—CAB has attributed this marked downward trend in international subsidy to two factors: the decision in the trans-Atlantic mail rate case and the Defense Department's new policy of shipping its mail by commercial carrier.

Actually, a good part of the Fleet Post Office and Army Post Office mail has traveled on the overseas airlines in the past, but late last year the military decided all mail would go by that method. Since some mail was already moving, it is difficult to estimate the exact effect the new program will have on airline revenues, especially in the Atlantic. A reliable guess is that it will mean a total of at least $18 million a year once it gets fully under way.

The other factor, the trans-Atlantic mail rate case, is in the position of being finally decided by CAB, but remaining unsettled. The Board issued a decision in December on rates for periods as far back as 1946 for Trans World Airlines, Pan American World Airways and American Overseas Airlines, now merged with Pan American.

▶**Drastic Cuts**—The decision cut drastically the amounts recommended for the carriers earlier by an examiner in setting the future rates.

In deciding the case, CAB set some precedents. Losses suffered by TWA in a pilot strike were not allowed in figuring mail pay. In figuring Pan American's rates CAB decided to quit underwriting Pan Am's use of the Boeing Stratocruiser, which the Board figures has cost $16 million in subsidy in a past four and a half year period.

The decision also set a new 9% rate of return instead of the former 10% in figuring international rates. The Board observed that international operations are considerably less uncertain and risky than they were at the outset of the service.

All the carriers involved have objected to the findings in the trans-Atlantic mail case and have asked the Board to reconsider. They have also filed motions for review in the United States Court of Appeals in case the CAB doesn't see it their way.

▶**Upset in Court**—The big question remaining in the trans-Atlantic rate case, and in all international rate cases, was raised last February by the Supreme Court when it issued its now famous decision on the offset principle. In the

Chicago & Southern case, the court found that an airline with both domestic and international operations, must be considered a single entity in setting mail pay. Excess profits in one operation must be used to offset losses in other operations before subsidy requirements are set.

This decision struck at the roots of CAB policy, since the Board had been using the opposite philosophy of treating domestic and overseas operations as separate entities. If the issue is finally settled along the lines set out by the court, a change in subsidy policy and practice will necessarily have to be made by CAB.

Recognizing this fact, the Board set TWA and PAA's future trans-Atlantic rates, which cover operations as far as India, subject to further adjustment under the new offset principle. An investigation now is under way to determine what effect it might have on the case.

CAB wants Congress to enact legislation which would clear up the matter and, in effect, reverse the opinion of the Supreme Court.

Coach and Credit

In traffic and sales, the outstanding factor in 1954 was the tremendous blossoming of aircoach with U.S. flag carriers. Last year about half of all traffic was coach. The North Atlantic market was dominated by it to the extent of about 60% of all traffic.

▶ **Around the World**—This year, for the first time, a passenger could fly around the world in coach service and at a cost of about $1,300 compared with about $1,700 for first-class. This service was inaugurated by Pan American, the only U.S. flag carrier offering round-the-world service. Pan American has gone in heavily for aircoach since it was introduced in 1952. TWA, Northwest and other American-flag carriers feel as strongly about it and are pushing the tourist business, too.

Aircoach, being new to the international trade, has raised complex problems due to its highly seasonal characteristics and other factors, but the industry is willing to take the problems on when it sees how much business aircoach produces.

Another boost to business has been the "fly now, pay later" plans which were introduced during the year. The idea of selling air travel on the installment plan, just like automobiles and refrigerators, is a good indicator of how commonly accepted air travel is with the American consumer.

By its character, international travel is an easy thing to sell. By adding the practical factor of immediate availability to the romance of travel abroad, the airlines have found a sales gimmick that is proving effective in boosting business and will undoubtedly continue to do so, especially if the economy remains stable and strong.

▶ **Air's Big Share**—The U.S. international airlines are continuing to dominate travel between the United States and the rest of the world. Immigration and Naturalization Service statistics show that air travel is leading ocean travel by a wide margin, and that U.S.-flag airlines are carrying about two thirds of the air passenger traffic to and from United States ports of entry.

In the year ending June 1954, a total of 3,024,730 passengers passed through U.S. ports. Of these, 1,852,722 traveled by air, 1,229,586 of the air passengers were carried by American carriers.

The struggle to maintain this dominance is becoming more difficult as the number of airlines flying under foreign flags increases and the established foreign airlines pioneer new services, such as the Scandinavian Airlines System's trans polar service.

No new airplane types were introduced by American flag carriers during the year. Service was carried largely by DC-6, Constellation and Stratocruiser equipment. This year will see the introduction of the DC-7B to international service on the routes of Pan American. TWA is taking delivery this spring on an order of new long range Super Constellations, and Northwest will put four new Super Constellations in service this year. The DC-7C, a larger version of the DC-7, will be delivered to Pan American next year.

▶ **Turbine Transports**—The question of turboprop and turbojet equipment is one that is more vexing to the international carriers than it is to their domestic colleagues. The price of modern airplanes being what it is, re equipment programs can't be undertaken too often. Since the international carriers are getting their advanced piston-engine equipment nearly two years after the domestic airlines, their depreciation and obsolescence problem is greater in viewing the eventual switch to turbine operation.

From a competitive standpoint, the British and their customers had the jump on American carriers while the Comet lasted, but the disasters of last year have removed the jet transport from the scene for a while and BOAC has been forced to buy American equipment, including authorization of a DC-7C purchase, to remain competitive.

CAB Actions

The Civil Aeronautics Board dealt with trans-Pacific routes in the major international route case decided last year. In a series of actions marred by inept handling, the White House

changed and then made final the CAB recommendations.

▶**Going in Circles**—The key issue involved was Pan American's efforts to get the Great Circle route now flown to the Orient by Northwest. CAB decided that Northwest should be permanently certificated over the Great Circle route and that Pan American should be confined to the central Pacific crossing. The President changed this to the extent of deferring a decision on Pan American's Great Circle bid and renewing Northwest temporarily for seven years.

Requests filed by TWA and Northwest for route extensions which would have completed a second American-flag round-the-world service were denied.

In a hassle over the West Coast-Hawaii case, which was decided at the same time, Pan American and Northwest wound up being renewed for three years from Portland/Seattle to Hawaii after Northwest was chosen by CAB and Pan American by the President for single carrier service between the points.

▶**Still Unsettled**—Another major route case, the Balboa through-service case, ended last year as it has in other years—unsettled. The case has been shuffled back and forth between the White House and CAB a number of times by both Truman and Eisenhower.

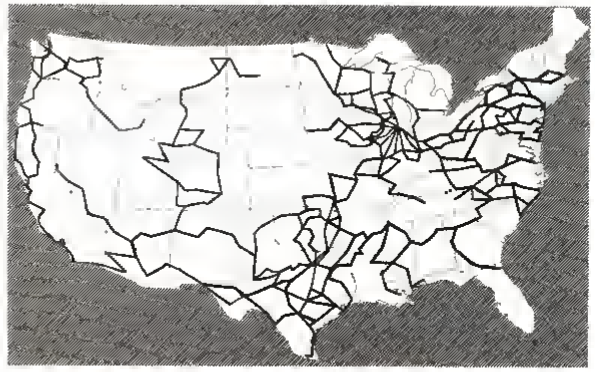
Last year, CAB took another look at the case, which involves through-plane service between New York and Balboa, Canal Zone, and South America. During the proceeding, the Board tried to get Braniff Airways and Panagra to merge. Panagra had been hit earlier with a monopoly suit by the Justice Department. The merger attempt was an ill-fated project from the beginning, and nothing came of it.

The Board is reported to have closed the case, decided it and sent it to the White House, where it rests now.

Last January, India decided to terminate its bilateral air agreement with the United States. Talks had been going on for months between the governments with little success. India wants an agreement designed to protect and foster the growth of Air India International. The State Department couldn't agree to the Indian proposals, so the bilateral was terminated. Efforts will be made to draw up a new one.

Meanwhile, the schedules of TWA and Pan American have been cut, but both carriers still are operating in and out of India.

Last year was a good one for the international carriers. The success of aircoach and pay-later plans contributed heavily to traffic and revenue gains. As these fields are further developed, and as new equipment goes into service, this year is expected to set new records.



U. S. LOCAL SERVICE ROUTES

Certificate Doubt Hampers Locals

By Katherine Johnsen

The local airline industry—which, in nine years' vigorous growth, has introduced air service to over 250 smaller cities—is insisting again this year on permanent status in the domestic air transportation network.

Since the first local service certificate was awarded by Civil Aeronautics Board in 1946, the industry has expanded from a system of 6,494 route-miles in 1947 to 21,993 miles. Its services blanket the country with the exception of a few areas: Kansas-Nebraska, in which transcontinental carriers offer frequent service to intermediate points; New England, in which Northeast Airlines performs local service, and Florida.

►**Here, But . . .**—It seems to be unanimous that local lines are "here to stay."

The controversy: Should permanent certificates first be granted, to enable the lines to reduce their subsidy needs, or should the subsidy needs first be reduced to merit permanent certificates?

CAB's majority—with member Joseph Adams dissenting—is firm that the subsidy reduction comes first. They warn that if route systems are "frozen" under

Growth of the Local Service Airline Industry

The local service airline industry has tripled its route mileage, quadrupled its revenue plane mileage, and boosted its number of revenue passengers by ten times, since operations were started in 1947. The industry's revenue passenger load factor has improved by 50% and its revenue ton-mile utilization factor by 20% over the seven years.

	Route Mileage Operated (Unduplicated)	Revenue Plane-Miles (000)	Revenue Passengers (000)	Revenue Passenger Load Factor (%)	Revenue Ton-Miles (000)	Revenue Ton-Mile Utilization Factor (%)
1947	6,494	10,104	237	30	4,738	32
1948	11,088	18,093	428	27	9,102	28
1949	13,408	23,802	681	29	14,261	27
1950	18,290	33,778	983	33	21,552	30
1951	20,800	37,797	1,462	38	30,709	35
1952	21,696	40,697	1,704	39	35,131	36
1953	21,791	44,842	1,998	39	39,626	36
1954 Increase	21,993	48,409	2,416	45	46,962	40
1954 over 1947	239%	380%	918%	50%	891%	25%

permanent certificates the local lines will continue to rely on government help.

Renewing the Board's opposition to legislation requiring permanent certificates, CAB acting chairman Chan Gurney explained:

"Permanent certification would render extremely difficult . . . route realignments. Therefore, the Board does not feel that permanent certification should be granted unless it finds that a carrier can reasonably be expected to attain self-sufficiency at some foreseeable date . . .

"There is no showing of reversal of the unfavorable trend in subsidy need; there is no indication that there will be any immediate reduction in the government support needed to sustain local service operations, and there is no indication that the industry may be able to approach self-sufficiency in the foreseeable future."

Subsidy Goes Up—CAB reports on subsidy payments to the industry, by fiscal years: 1951, $17.2 million; 1952, $19 million; 1953, $21.7 million; 1954, $25 million; 1955, $25.8 million. The Board estimates a fiscal 1956 payment of $25.9 million.

In fiscal 1951, the subsidy of $18.8 million to the domestic trunkline system exceeded the local airline subsidy. It wasn't until the following year that the trunkline subsidy dropped sharply, to $6.3 million.

The local service airline industry, though, argues that permanent certification is the first essential step toward getting off subsidy. These are reasons industry spokesmen give:

• **Financing.** Financial institutions hesitate to advance capital to companies with a temporary lease on life. With permanent certificates, much lower interest rates could be obtained, decreasing the subsidy need, local service officials say.

In addition, companies themselves refrain from making capital investments for equipment improvements—such as high frequency omni equipment—which would reduce operations costs, and cut subsidy need.

• **New aircraft.** Local airline spokesmen say the industry is stymied in obtaining a replacement for the pre-World War II DC-3, until it is given permanent status. They point out that operating costs of the DC-3 are too high for most of the thinly traveled segments of local lines, and that replacement parts for the obsolescent plane are difficult to find and increasingly expensive.

They emphasize that a new plane specifically designed for local operations—low in operating cost and suited to small and undeveloped airfields—would mean major progress toward elimination of subsidy.

But even if the government were to finance the development of prototype for a new feederline plane, aircraft manufacturers are reluctant to undertake the project while a question mark hangs over the existence of the local airline market.

• **Community support.** Local communities hesitate to make airfield and other transportation facility improvements for a carrier which may be gone tomorrow, industry spokesmen complain. They anticipate that permanent certification would spur local enthusiasm that might go a long way toward generating new traffic.

• **Legal expense.** Processing renewal applications before CAB involves a major expense for local lines and virtually a 100% diversion of management from operations, spokesmen object.

Last summer, CAB reported that it had allowed lines a total $495,758 as expense for processing certificates. The lines had claimed $981,190 expense. The CAB allowance equaled about half of the industry's deficit in 1953 ($1.1 million) and about three-fourths its deficit in 1952 ($760,000).

The decision as to whether the existing local service airline industry is to be put on a permanent basis will probably be left to the President this year—

Local Service Industry's Financial Status

Mail and subsidy payments to the local service airline industry increased by over four times, from 1947 to 1954, but the industry's commercial revenues developed at a much greater rate, increasing by over twelve times over the seven years. Profit wise, 1954 (the year ending Nov. 30, 1954) was a blue-ribbon year. The industry's profit totaled over $2 million, and only two of the 14 carriers showed deficits.

(Figures in thousands of dollars)

	Operating Revenues			Operating Expenses	Profit
	Commercial	Mail and Subsidy	Total		
Industry:					
1947	$2,484	$5,920	58,404	59,006	($602)[2]
1949	6,667	12,140	18,807	19,160	(353)[2]
1951	17,351	18,575	35,926	35,054	872
1953	24,319	24,182	48,501	49,650	(1,149)[2]
1954[1]	29,158	25,257	54,415	52,364	2,051
Individual Carriers 1954[1]					
Allegheny	2,867	1,617	4,484	4,698	(214)[2]
Bonanza	1,052	889	1,941	1,865	76
Central	479	1,969	2,448	2,245	203
Frontier	2,325	2,821	5,146	4,830	316
Lake Central	702	1,816	2,518	2,248	272
Mohawk	2,773	851	3,624	3,475	149
North Central	3,383	2,363	5,746	5,576	170
Ozark	1,552	1,795	3,347	3,299	48
Piedmont	4,054	2,203	6,257	6,020	237
Pioneer	2,793	1,476	4,269	3,979	290
Southern	1,398	1,949	3,347	3,227	120
Southwest	2,278	1,165	3,443	3,158	285
Trans Texas	1,832	2,800	4,632	4,412	220
West Coast	1,670	1,543	3,213	3,334	(121)[2]

[1] For year ended Nov. 30, 1954.
[2] Deficit.

Congress appears certain to pass legislation directing this.

▶ **Progress Toward Agreement**—The noteworthy development during the past year has been the narrowing of the difference of opinion between Congress and the industry on the one hand, and the Administration and CAB on the other, over the issue.

From opposite poles, there has been this progress toward agreement:

• In a "clarification" last November of the recommendations of Air Coordinating Committee's report, Robert Murray, former Administration spokesman as Undersecretary of Commerce for Transportation, went so far as to suggest that "a few" local service airlines have already merited permanent certification. The clarification came after the report, drawn under Murray's direction was widely blasted in Congress' last session as proposing "the gobbling up" of local lines by major carriers.

• CAB's Gurney, speaking for the Board's majority, has come out in favor of "longer-term" certificates and suggested seven-year renewals. At present, only two of the local lines—Mohawk Airlines and Piedmont Airlines—are on seven-year certificates. The terms of the other 12 are from three to five years.

In addition, member Adams has taken issue with the Board majority and proposed a middle-of-the-road approach.

Give certificates immediately to carriers measuring up to four standards established by CAB as "measurements of financial operating results." This would mean prompt permanent certification of five lines: Mohawk, Piedmont, Southwest Airways, Bonanza Air Lines, and Pioneer Air Lines.

Adams qualified, "To preserve flexibility as to future adjustments . . . I would suggest that the new permanent certificate represent a skeleton of strong terminal points, with the intermediate cities qualifying for permanency as they reach a volume of traffic generation sufficient to reimburse the carrier for all direct costs and a reasonable share of indirect costs."

• Meanwhile, there is strong support in Congress for a modified approach. Legislation introduced by Sen. Warren Magnuson, chairman of the Senate Interstate and Foreign Commerce Committee, reflects Adams' views.

It would require the Board to award permanent certificates to all existing local service lines in four months after enactment, unless their service during the period were "inadequate and inefficient." But it would empower the Board to keep on temporary status "those intermediate points which have, over a reasonable period of time, generated insufficient traffic and revenues to reimburse the applicant carrier for its direct costs and a reasonable share of its indirect costs incurred in serving such points."

▶ **Almost, But Not Quite**—The local air line industry, under the leadership of Donald Nyrop, former counsel of the Conference of Local Service Airlines and now president of Northwest Air lines, almost achieved legislation, a year ago, putting it on a permanent basis—the House passed the measure and it was approved by the Senate Commerce Committee.

• Failure to pass the Senate was due to two factors:

• **Commerce Committee tacked** on an amendment also authorizing permanent certification of the certificated all cargo carriers, which aroused opposition of scheduled trunk passenger carriers.

• **Unanimous consent required** for consideration in the final rush toward adjournment permitted one senator—Prescott Bush—to block action.

▶ **Position Better**—Under the leadership of John Floberg, former Assistant Secretary of Navy for Air, who has succeeded Nyrop as counsel of the conference, the industry is in a more favorable position now than it was a year ago to win its case for permanent certification. Its 1954 performance—based on statistics for the year ended Nov. 30—shows notable improvement over 1953 and previous years.

• Commercial revenues mounted $5 million—from $24.3 million in 1953 to $29.1 million. Revenue from government mail and subsidy payments though, increased only $1 million.

• For the first time, in 1954, the industry's commercial revenue was substantially greater—$4 million—than its revenue from government payments. Through 1952, government revenue exceeded commercial revenue. In 1953, commercial revenue of $24.3 million approximated mail and subsidy revenue of $24.1 million.

• For the first time, in 1954, the industry showed a substantial profit—$2 million. In the eight previous years of its existence, the industry had three profit years—1948, 1950, and 1951—for which profits totaled $1.4 million, less than the 1954 figure. Losses in the other years totaled $2.9 million.

▶ **Bright Developments**—Developments which promise a brighter future to the local service industry are:

• **The trend in trunkline industry,** with its new high-speed planes, to give less service to intermediate points is opening up new traffic for local service.

C. R. Smith, president of American Airlines, has backed strengthening of local service to feed into trunk carriers.

The pressure from Congress to give each local service system two strong terminal points continues.

United Air Lines' president, W. A. Patterson, advocates that the nonsubsidized trunklines take over local service routes to reduce the government's subsidy bill. He appears, though, to be a minority voice.

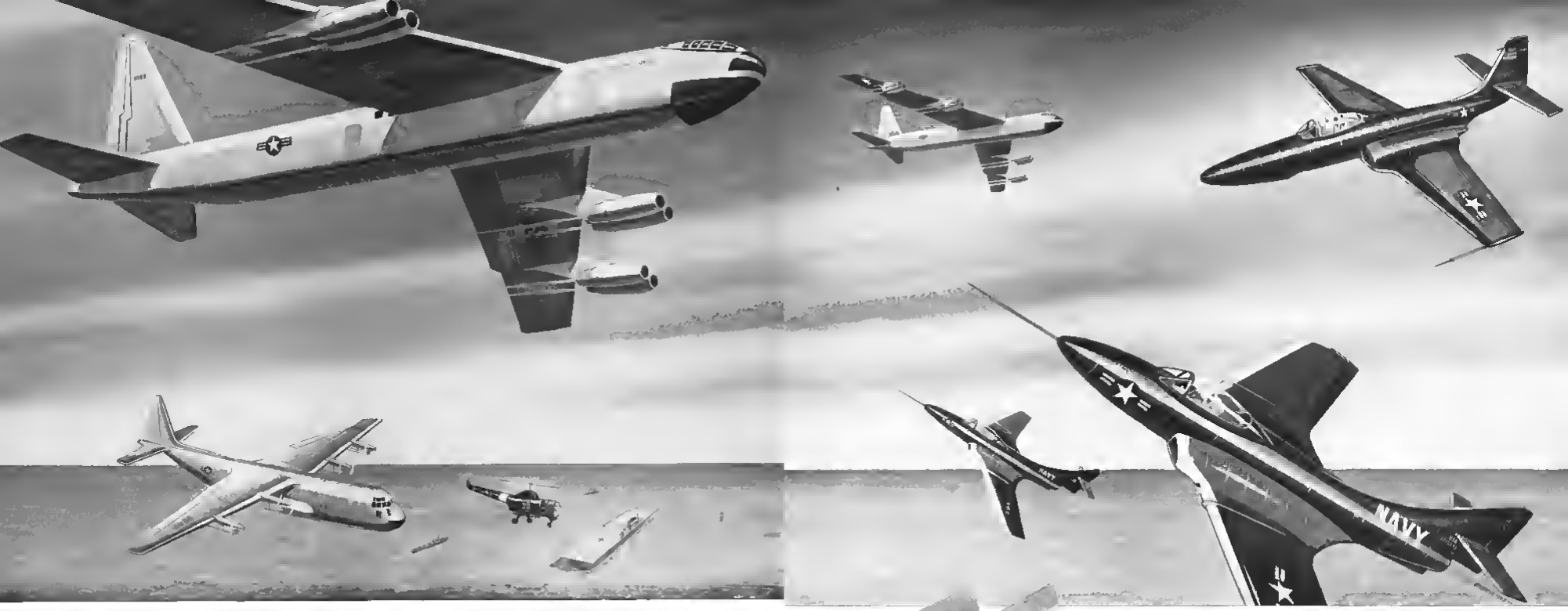
CAB did, last December, approve the merger of a small trunk carrier, Continental Air Lines, and Pioneer.

• **A new multiple-element formula** for determining "service" mail pay would greatly reduce the local service lines showing of "subsidy." A substantial part of what is now listed in the "subsidy" column would be moved over into the "service" mail pay column.

CAB recognizes that the present formula of setting "service" mail pay on a ton-mile basis favors the transcontinental lines that ship large bulks of mail great distances. It does not reflect cost to carrier of frequent landings.

CAB has met the opposition of United and other transcontinental carriers in its proposal to apply a multiple-element formula—which would provide for an enplaning fee as well as a rate for in transit shipments. After the issue is resolved for the trunk industry, the Board plans to apply it to the local service industry.

• **The Post Office Department's** experiment of shipping first-class surface mail by air to expedite delivery on a "space available" basis has already opened the way for the local airlines to make a more favorable showing on subsidy.



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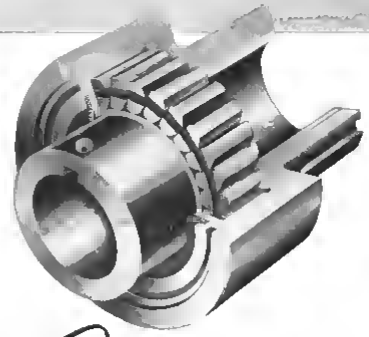

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Air Freight and Air Express Traffic (Domestic)

TRUNKLINES	TON MILES (000) FREIGHT		EXPRESS	
	1953	1954	1953	1954
American	52,320	56,003	10,275	8,595
United	27,620	33,610	10,596	10,471
Trans World	18,933	21,310	7,697	6,902
Eastern	8,130	10,350	4,080	4,318
Delta-C&S	5,968	5,739	2,402	2,465
National	5,537	4,469	621	632
Capital	4,154	4,209	2,705	2,422
Northwest.	3,701	4,469	1,729	1,898
Braniff	2,766	2,916	1,190	1,176
Western	1,348	1,796	753	760
Continental	842	933	192	221
Northeast	270	299	177	171
Colonial	252	294	97	63

CARGO LINES	1953	1954
Flying Tiger Lines	37,741,124	27,413,051
Slick Airways	45,600,112	34,883,258

Source CAB Reports

Airfreight Moves Ahead Slightly

The air cargo industry looks back on 1954 with mixed emotions While gains were registered in some fields, total figures indicate that progress has slowed and that over-all traffic is virtually the same as it was last year.

Other forms of transportation—rail and truck—show actual declines in freight traffic, and by these standards, airfreight looks good But airfreight is an industry that still has a long way to go to take up the slack between potential and accomplishment, and in this light, 1954 figures don't look so good.

Last year's results show once again thet airfreight has a long hard road to travel before it measures up to the rosy promises made in its name by the experts in past years

While the current situation is viewed with some gloom by industry observers, there is an almost universal feeling that airfreight has a great future once some rather formidable problems are licked. There are predictions that in 10 to 20 years, cargo will dominate passengers as the mainspring of airline business

► **Last Year's Figures**—Here is how traffic shaped up last year

• **Trunk carriers** flew about 146 5 million ton miles of freight in scheduled and non-scheduled services, an increase of about 10% over 1953 They carried about 40 million ton-miles of express, a drop of 2 5 million ton miles from the previous year

• **All-cargo carriers**—Flying Tigers and Slick—were off sherply from 1953 figures. They flew a total of 62 million ton miles, compared with 83 million for 1953 Riddle flew about 15 million ton miles, including both international and domestic operations

• **Local-service carriers** flew about 1 1 million ton-miles of express and 1 18 million of freight, compared with 955,000 ton-miles of express and 1 18 million of freight in 1953

• **International carriers** flew about 82 million ton-miles of freight last year, compared with 75 million in 1953

• **Irregular carriers** freight operations are hard to assess because of incomplete reporting, but the best estimate seems to be about 60 million ton-miles, with less than 10 million of that in domestic commercial traffic

Total domestic operations are off nearly 10 million ton miles from the 273 4 million ton-miles recorded in 1953. This drop can be traced to the loss suffered during the year by Flying Tigers and Slick Both recorded gains during the short time they operated separately at the end of the year and are expected to do better in 1955

► **Military Contracts Down**—A contrib-

uting factor in the 1954 picture was the fact that it was the first year in which military contract operations were negligible. Cargo operations last year had to depend almost wholly on commercial traffic.

This year will see the return of the military to the scene, although on a much smaller scale than in the 1950-53 period of the Korean war. Contracts have been signed by Flying Tiger, Seaboard & Western, and Transocean Air-Lines to take part in a Formosa airlift, and the Air Force is taking bids from commercial carriers for a stepped-up engine airlift.

▶ **Merger That Fell Through**—The biggest single factor in the airfreight picture in 1954 was the ill-fated merger of the Flying Tiger Line and Slick Airways. At the beginning of the year, the projected cargo combine was viewed as a real shot in the arm to all-cargo operations. As the year progressed, difficulties arose, largely over labor provisions insisted upon by CAB, and the two carriers called the whole thing off.

While the deal was being consummated, Slick and the Tigers began to mesh operations, so that by the time it fell through, they were, in effect, operating as a merged company. The confusion involved, first in getting the companies together and then taking them apart, is seen as the major reason for the loss of traffic in the all-cargo category. The two companies had to pay too much attention to the merger to do an effective sales job in an industry that requires intensive sales promotion.

▶ **Competitive Struggle**—The Slick-Flying Tiger situation muddies estimates of the gains made by the combination carriers—mainly the big trunks like American Airlines, which makes a big business of airfreight and makes no bones about wanting the all-cargo carriers out of the business. Clearly, the combination carriers have taken a chunk of business away from the all-cargo people, but the diversion was undoubtedly affected by the Slick-FTL troubles and the true position of the two types of carrier remains unclear.

One thing is certain—the more aggressive combination carriers are going to continue to keep the pressure on in an effort to prove that independent all-cargo operations aren't necessary, that the combination carriers can handle all the business available.

▶ **Airfreight Renewal Case**—The whole question of the place of all-cargo operators in the air transportation pattern is up for review by CAB right now in the airfreight renewal case. The initial five-year experimental period was up last year, and the Board is now assessing the results of operations thus far and considering whether the pres-

ent carriers should be recertificated.

The east-west portion of the case has been held up by the Slick-Flying Tiger troubles, so CAB has severed the north-south portion and is proceeding with it independently. In this segment, Riddle Airlines, which showed considerable improvement last year, is trying to expand its services along the eastern seaboard. Riddle's Puerto Rico route isn't an issue in the case.

U. S. airlines, one of the original all-cargo lines, which later dropped out of the picture, is trying to get back into operation again.

The trans-Atlantic cargo case, where CAB is supposed to have recommended Seaboard & Western Airlines for a trans-Atlantic all-cargo certificate, is being held up in the White House. Opposition from scheduled carriers is considerable, and chances of getting any positive action appear to grow dimmer as the months go by. Seaboard flew a total of 10 million ton-miles last year.

Meanwhile, Airwork, Ltd., a British operator, has been cleared by the White House for trans-Atlantic cargo operation and is getting under way with DC-6As that are leased from Slick Airways.

▶**The Mail Flies**—One bright spot in the cargo picture was mail operations. Not only did regular airmail traffic increase solidly, but the Post Office Department expanded its controversial surface-mail-by-air program. The experiment was started in October 1953, between Chicago and Washington and New York. Since then it has been expanded south to Florida and to over a hundred points on feeder routes. Last fall, it was further expanded to a 20-city area on the West Coast, and now totals about 13,000 tons a year.

At first, the idea was viewed with great enthusiasm by the affected air carriers. Since then, sobrer second thoughts have raised some doubts.

True, the mail fills empty space and the income is pure gravy. But most of it goes at normal freight rates—about 18-20 cents a ton-mile. Some in the industry are fearful that CAB and Congress are going to start wondering out loud why airmail can't go at a rate near this, rather than the much higher air mail scales, if the surface mail is moving so successfully at the lower rate.

The railroads don't like the experiment and are showing their displeasure through court action. They have questioned the legality of the whole operation and court findings have thrown its status into considerable doubt. Legislation may be necessary to continue it.

The scheduled airlines recognize the income value of airmail and air parcel post and they are carrying on an inten-

sive promotional campaign through the Air Transport Assn. to increase public use of both.

This year, the Department of Defense is going to greatly increase its program of sending military mail overseas on commercial air carriers, and this will mean added cargo revenues for international carriers—estimates run around $18 million a year.

► **Forwarder's Place**—The airfreight forwarder got a boost last fall in a CAB examiner's report that recommended quite liberal regulation for the forwarding industry.

Many airlines did not like the provisions of the report, which turned down the application of Air Cargo, Inc., an airline-owned operation.

The exact position of the forwarder remains unsettled while CAB considers his case, but most observers agree that he has a definite part in the airfreight picture—if only as another salesman in an industry badly needing vigorous sales activity.

► **Rates & Costs**—The air cargo industry has a couple of basic, interrelated problems to lick before it can really hit its stride.

Industry experts all agree that rates must go down before airfreight can really compete with surface transportation. And in order to reduce rates, carriers must have an efficient all-cargo airplane that will let them reduce costs.

Carriers are caught in a real dilemma in the rate situation. Current rate levels are a worry because they don't produce enough revenue to cover costs. This is bad enough to a combination carrier which has a big passenger business to carry the cargo operation, but it's disastrous to the all-cargo operator who is supposed to live on the revenue from freight alone.

Industry opinion is that, given current equipment and costs, rates will go up before they do down. And yet, operators are loath to raise tariffs for fear of pricing themselves out of the market.

It's a vicious circle of too-high rates causing low traffic volume, and low traffic volume creating a need for still higher rates.

The key to the rate situation lies in the aircraft. The fleet now consists mostly of C-46s, DC-3s, DC-4s and DC-6As plus some Super Constellations which went into service with Seaboard & Western this year.

None of these aircraft are true cargo carriers. All were designed as transports and consequently their costs are higher than they should be for hauling freight. The DC-6A has the best operating costs available, but high purchase price forces depreciation costs up and cuts its advantage.

One relief for lack of cargo planes

this year is the possibility of conversion of the growing surplus of DC-4s to cargo. As the larger planes go into passenger service, the DC-4 becomes obsolete. And as more of them become available, their sale value drops off. Since they are already depreciated, some carriers may figure it's cheaper to use them for cargo than let them sit around or sell them cheaply.

▶ **True Cargo Plane Needed**—Eventually, cargo operators are going to have to get a true cargo airplane. It must have low direct operating costs and must be designed to cut such costs as loading and unloading.

The basic problem is that there isn't a large commercial market for such an aircraft, and spreading developmental costs over a small number of planes would make them too costly to purchase. Some cargo airplanes—the C-119 for instance—have been designed and built for the military, but even assuming they were cheap and efficient enough to work out in commercial traffic, they are unavailable.

In recent years, there have been a number of plans designed to make such an airplane available to cargo carriers at a practical cost, including much talk of the Air Force paying for the initial development of a cargo plane. Thus far, nothing much has come of such projects, but most observers feel that if a new plane is to be built, the government is going to have to bear the financial brunt in one way or another.

The possibility of some relief came early last month when the Navy leased an R6D Skymaster (DC-6A) to Slick Airways as the beginning of a test program to see whether military transports could be maintained in readiness by commercial operators at no cost to the government.

▶ **Increase Expected**—The overall traffic curve for the airfreight industry is expected to go up this year, but not in any great degree. Best guesses are that volume will go up about 7-10%—a pretty healthy increase, but not enough progress toward the 400 million domestic ton miles predicted three years ago for 1955 by a CAA study.

The addition of added freight aircraft is expected to contribute to added volume this year. American Airlines has seven DC-6As on order and United Air Lines has ordered five. Other carriers are willing to buy the freighters when they become available.

Part of the future depends on the simple principle of momentum. As volume grows, costs go down and air cargo becomes better known. These factors contribute to a snowballing market. This phenomenon has yet to occur, but hopes are high that, as long as the economy remains on the upgrade, 1955 will see the start of it.

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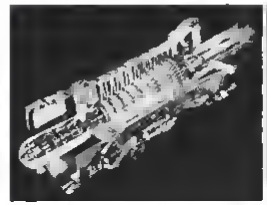

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Nonskeds Awaiting Legal Rulings

The nation's irregular air carriers wound up 1954 in just about the same position they were in at the beginning of the year. Traffic was about the same as it was in 1953, and once more the carriers ended the year without having their legal status settled.

Progress was indicated in air safety, a factor once considered a blot on the industry picture. Until a Johnson Flying Service DC-3 crashed late in December, the carriers had a fatality-free safety record for the year.

Traffic for the year amounted to about 1.3 billion passenger-miles and 60 million cargo ton-miles. More than 40% of the irregulars' business is in common carriage, and a like amount is in military business. About 10% is done in commercial contract and charter traffic.

During 1954, the industry continued to shake down and showed definite signs of stabilizing after a decline from the larger but more volatile form it had in the years immediately after World War II. There were 52 operators in business in 1954, but only about 40 were really operating all year.

The irregular air fleet has 143 aircraft, including 55 C-46s, 39 DC-4s and 39 DC-3s. During the year, the Air Force offered for sale the C-46s it had been leasing.

Progress was made on the industry program to effect improvements in the C-46 to help it meet Civil Aeronautics Board standards. These modifications are mainly concerned with improving firewalls and engine cooling.

▶**New 'Grandfathers'?**—In 1954, as in previous years, the irregulars continued to operate under the theory that they were building "grandfather rights" it would be impossible for the government to take away from them. The CAB estimates the large irregular carriers represented a total investment of $13 million at mid-1954.

The industry is nearly 10 years old and has been operating during that time with no clear definition of its legal or regulatory status. Half-hearted attempts have been made from time to time by the Civil Aeronautics Board to bring some order to the system, but no real policy has been set up.

It is hoped by the nonskeds that 1955 will bring a decision in CAB's Large Irregular case. It was instituted to determine the purpose and function of the industry and has been in the works nearly four years. The record developed is monumental. A report is said to be forthcoming in a few months.

The results of the case should settle the issue, but it is difficult to determine what the answer will be. Within the industry itself there is considerable difference of opinion what its place in the air transport pattern should be. Most agree that the irregulars should perform service supplementary to presently certificated services and that a type of certificate for such service should be specified and granted.

▶**What Type of Service?**—There is also a great range of opinion as to what this service should amount to. Some carriers would be satisfied if CAB just continued their authorization much as it is—a letter of registration. Others would like a more positive and expansive certificate, and a few want actual limited certification as scheduled carriers for certain types of operation, largely aircoach.

The scheduled carriers are opposed to the irregular operation in general, although there is a great deal of confusion and misconception involved. Ire of the scheduled industry is directed mainly against irregular aircoach operations, which are conducted by a very small portion of the industry.

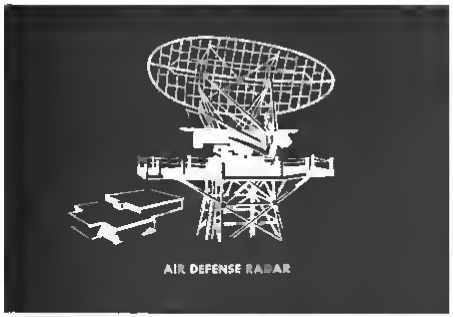
In its brief to the examiner in the Large Irregular case, the Aircoach Transport Assn. maintained that there is a need for additional and supplementary service.

"No threat exists," said ACTA, "against the principal business of the domestic trunkline carriers. No applicant is seeking to carry their first-class traffic. Rather, the applicants are seeking permission to expand auxiliary fields, providing supplemental and additional air service to the aircoach, air-freight and air charter markets. These markets have not been developed by the certificated carriers, it is neither necessary nor desirable to reserve these markets for those carriers."

▶**Not All Aircoach**—The frontal attack of the scheduled industry on the irregulars has served to cloud somewhat the true economic structure of the irregular industry. Most of the fighting is over aircoach operations, such as those conducted by North American Airlines.

Actually, the great bulk of the irregulars are engaged in other types of operation. The biggest part of the non-aircoach business is with the government. Military charters and commercial air movements (CAM) support the greatest number of irregular operators. Civilian contract and charter work accounts for about one-sixth of non-aircoach traffic.

Many carriers also pick up considerable additional revenue from operations



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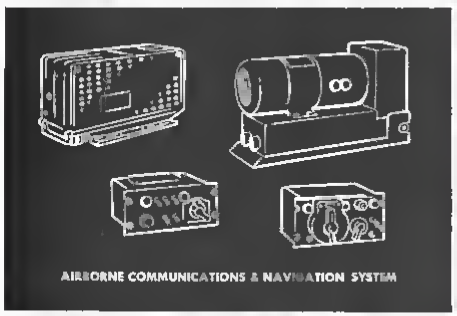

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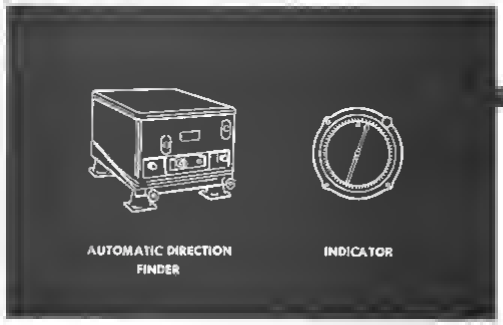

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The products you see on the opposite page are but a small sampling of their work. For Bendix Radio activities in aircraft communications, navigation, radar and missile guidance are vast and varied. Equally so are the facilities, tools and equipment with which Bendix People work. It's this combination of highly skilled manpower and production technique that assure unsurpassed quality, performance and dependability in every product that bears the "Bendix" name.

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such as leasing and maintenance.

Of the more than 40 companies now operating, only nine conduct aircoach operations. They offer services through three aircoach combines—North American, Skycoach and Safeway.

▶**North American's Case**—The largest by far is North American, a carrier which is a sort of case apart from the rest of the irregular industry.

As North American has grown in the past few years, it has drawn farther and farther away from the industry and ACTA's concerted attempts to crash the ranks of the certificated carriers. North American has been making efforts to disassociate itself from the industry, and the industry is considerably less cordial to North American.

The North American group has developed into a big business, grossing around $14 million and flying 329,476,000 revenue passenger-miles last year. The carrier has taken delivery on two DC-6Bs from Douglas Aircraft Co. to supplement its fleet of six DC-4s and, assuming it is allowed to stay in business that long, hopes to acquire more DC-6s this year.

Aircoach service is now offered by North American between New York and Los Angeles, Los Angeles and San Francisco, and New York and Miami. The service is operated through five letters of registration and with the help of numerous accessory companies which perform financial, leasing, maintenance, ticketing and other functions.

The only real hope for the future for an irregular carrier the size of North American is to get a certificate. The present regulations applied to irregular operations, and probably any enacted in the future, are too restrictive to allow a really sizable operation. Currently, the carrier is an applicant for certification in cases involving routes between New York and Florida, and New York and Chicago, service between the Southwest and the Northeast, and service to Denver. Out of one of these proceedings, North American hopes to get a certificate.

Meanwhile, the carrier has a battle on its hands just to stay in business. It is involved in a CAB compliance proceeding, as are Skycoach and Safeway, and the examiner has recommended in effect that the whole operation be ordered out of business. But the company will fight the case, and, judging from its past legal history, will probably be able to stay in business for a while at least through sheer judicial inertia.

North American in particular, and the irregular industry in general are burdened with high legal expenses because of their unsettled position.

▶**Air Clearing Houses**—The big hope in the industry now, outside of a settle-

ment of the Large Irregular case, is that CAB will approve a proposal for the establishment of an air exchange to coordinate activities.

Right now, there are two clearing houses through which irregular operators can obtain business. One is a control center run by ACTA in Washington, which handles military traffic for its 38 member carriers.

The Independent Military Air Transport Assn. runs a similar service for its 13 members, 11 of whom are irregular carriers.

Negotiations were under way late last year to merge the two associations, and the merger is expected shortly.

The air exchange proposed by the irregulars would coordinate the commercial market in the same way the military market is now organized. According to IMATA, a recent survey indicates that such a system could double traffic among present users and open up new markets.

▶ **What's Ahead**—The future of the irregular would seem to hinge on a number of factors. The most important is that of status, and 1955 appears to be the year when that question will finally be settled. Both CAB and Congress have various proceedings in the works.

It's a good bet that CAB will come to some definition of the irregular's position soon. The status of most of the surviving companies will depend on this action. They look for a certificate that will clearly set forth their function in the air transportation pattern as an industry which will supplement activities of currently certificated carriers and open new markets that current carriers can't exploit or can't be bothered with.

Along with such certification would have to come development of new markets. The current heavy dependence on military traffic is regarded by many as an unhealthy economic base upon which to build a sound operating structure. Commercial markets must be developed to a much greater extent than that shown by their current position.

Some of the large international irregular carriers are also making bids for certification. Early this year, Transocean Air Lines was defeated in two attempts to get certification for operation in the Pacific area, and a case involving certification of Seaboard & Western Airlines has been awaiting White House action for some time.

The whole issue may be settled by Congress this spring before CAB has time to make up its mind. Aviation bills filed early this year would draw clear lines of regulation for the irregulars. Any new laws probably wouldn't make the carriers too happy, since the proposed legislation is fairly restrictive.

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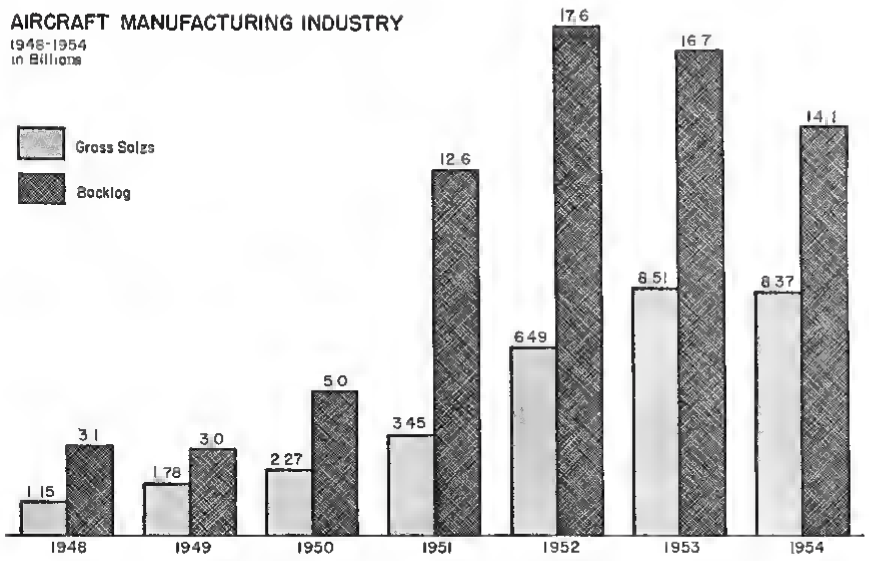
Industry must produce the best weapon systems today and prepare to produce the best weapon systems tomorrow, a year from tomorrow, and five, 10 or 15 years from tomorrow. Great new areas opening for development are: Supersonic aircraft, nuclear power, avionic controls, computer applications to military supply and operations, transports and guided missiles of all ranges. Opportunities are unlimited for those firms whose development and production will keep the U. S. ahead.



Technology Paces Airpower Dollar Race

The aircraft manufacturing industry enjoyed the most prosperous year in its 50-year history during 1954. Sales and profits reached an all-time high for the major producers and thousands of firms relatively new to the aircraft manufacturing field reaped substantial harvests from their aviation business.

Outlook for 1955 indicates that the aircraft manufacturing industry will continue on a plateau not far below the 1954 sales peak but will record profits of about the same magnitude. Key to the aircraft manufacturing market is the federal defense budget. For fiscal 1956 which begins next June the defense budget requested $32.8 billion of which about 66% will be spent for and in support of military airpower. This represents the largest peacetime expenditure on airpower in American history.

▶ **$9 Billion Expenditure**—Actual expenditures for procurement of military aircraft and related equipment for the Air Force, Navy and Army is scheduled to total about $9 billion for fiscal 1956—about the same level as in fiscal 1955.

This breaks down to $7.5 billion for aircraft; $700 million for guided missiles, and $700 million for ground based avionic equipment. In addition to this production program the aircraft industry will get close to another billion for research and development activity.

During fiscal 1956 the Defense Department plans to let new contracts totaling about $8.6 billion with the aircraft industry for military equipment. This new business will include about $6.5 billion for aircraft, $1.4 billion for guided missiles, and $700 million for ground-based avionics equipment.

Stiffer Competition

Two factors will dominate the manufacturing industry during the next few years:

• **Relatively stable market** for military airpower products that will offer an unprecedented opportunity for management to consolidate its financial gains, to affect economic production, and to do effective future planning.

• **Fierce technological competition** for the major shares of this stable market. Military procurement policies all point to more selective buying from firms that offer products featuring a large technical advance combined with prompt delivery and operational reliability.

This means that while the military market will assure a high level of sales and profits for successful manufacturers, not all manufacturers are likely to be successful competitors in this market. The key to successful management in the future market for aircraft, related equipment, avionics and guided missiles will be based on top-notch technical teams capable of reaching for major performance gains backed by the determination and financing to bring these new developments through the difficult period from concepts to workable hardware.

▶ **750,000 Workers**—The manufacturing industry employed a total of about 800,000 people during 1954. This is expected to be the employment peak with a slight decline to a level of about 750,000 workers during 1955. However, these figures do not include people working for some 60,000 suppliers and subcontractors serving the major aircraft, engine, missile and avionic manufacturers.

Department of Commerce statistics for the first three quarters of 1954 indicate the split of the aircraft manufacturing market among prime airframe builders, engine producers and the propeller and accessory makers. Out of total nine-month sales of $6,125 million, the airframe makers got $3,876 million. Of this total $483 million was in commercial business with the remainder military. Engine builders sold $1,528 million of which $125 million was commercial. Propeller manufacturers' sales totalled $142 million of which $23 million was commercial. Other equipment manufacturers registered sales of $579 million.

Tooling Problem

By the end of 1954 the manufacturing industry had completed virtually all of the plant expansion required for its present production level with a $3.5 billion investment in new facilities since 1950. Additional plant capacity will be required during 1955 for only a few specialized items such as missiles and avionic equipment. Not much more than $500 million will go into new plants this year. However, expenditures for new research and development facilities by the industry will continue at a high level, reflecting the emphasis on competition for technical gains.

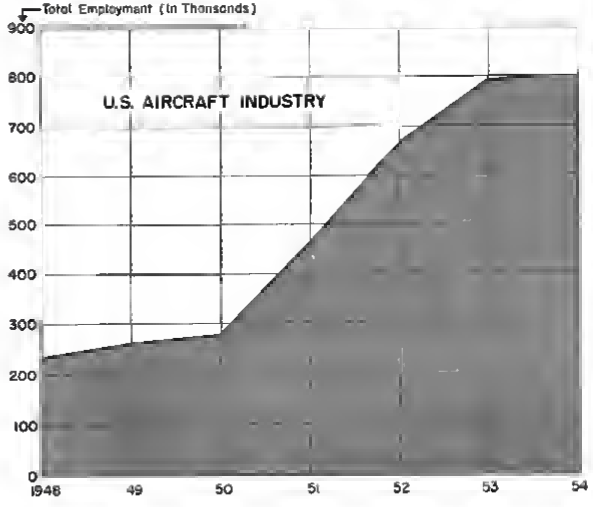
However, the industry faces a major production tooling problem as it switches from the 700-mph. aircraft types now in production to the new supersonic models operating in the 800-1,000-mph. speed range already on order for 1956-57 delivery. Aircraft Industries Assn. estimates that $500 million worth of new machine tools will be necessary for this switch. Defense Department already has programmed financing for about $300 million in new production tools during 1955 with the bulk of them earmarked for aircraft plants.

▶ **Steady Level**—Military aircraft production reached its peak during 1954 with slightly more than 150 million airframe pounds actually delivered. Slight decline in the production level will occur during 1955 as the stabilizing effects of the 1953 policy stretch out become noticeable. By 1956 the industry will stabilize at its steady production rate required to maintain and modernize the military force levels authorized and required for the maintenance of a permanent military airpower in being.

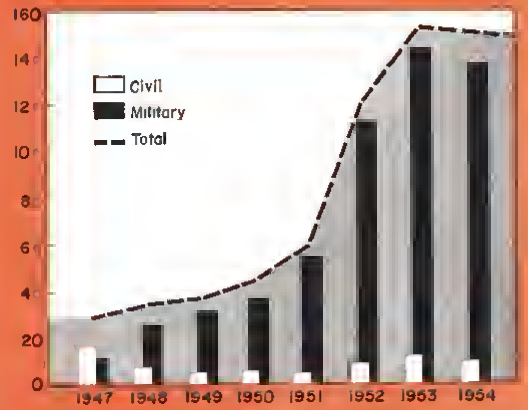
During 1955 the industry will shift from high volume production of existing types to initial production of the newer, faster fighters and bombers required to prevent the rapid obsolescence of combat airpower. Defense Department, stung by some major development difficulties on new aircraft types, will go slow during initial production period keeping quantities down to those needed for service testing. Not until major development hurdles are surmounted will the signal for large-scale production be given.

Technical Race

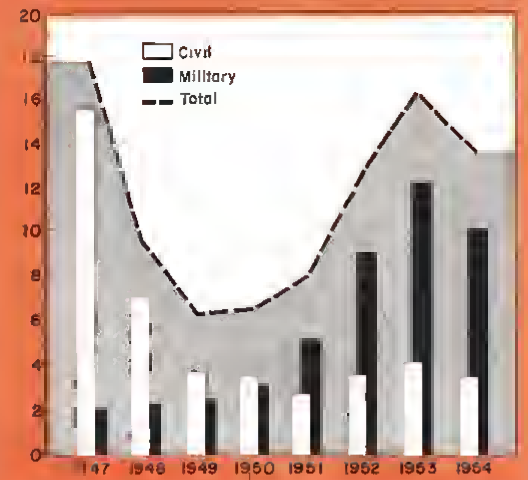
This technological race with the admittedly rapid progress of Russian airpower will dominate U.S. military aircraft requirements for the next decade even without a major nuclear war. There is no sign that the technological revolution in airpower that began with



Airframe deliveries in millions of pounds



Aircraft deliveries in thousands of planes



the jet engine and the atomic bomb is abating. All indications point to accelleration in all the technical fields related to aircraft development.

There have been fundamental changes in the aircraft industry during the past three years. Among them are:

• Expansion of the technical requirements of military and commercial aircraft has brought thousands of new firms into the aircraft field that had no aviation interests before 1950.

• Development of the weapons system concept in military aircraft has introduced new business relationships between suppliers and prime contractors that require a more extensive sales effort aimed at selling both the military and prime contractors.

Among the new fields that have or are becoming an integral part of the modern aircraft industry are:

• **Guided missiles.** This is growing into a billion dollar-a-year industry with about 60-40 split between production and research funds. It will expand rapidly during the next three years to a major part of the aircraft and related industries effort. This program is bringing many new firms into the aircraft orbit and also is putting many aircraft companies into business making missiles and equipment for Army, the sea-going Navy in addition to their traditional business with the flying Navy and USAF.

• **Avionics.** This field already has expanded during the past three years to where it accounts for 30% of every dollar spent on military aircraft. It will continue to expand during the next few years.

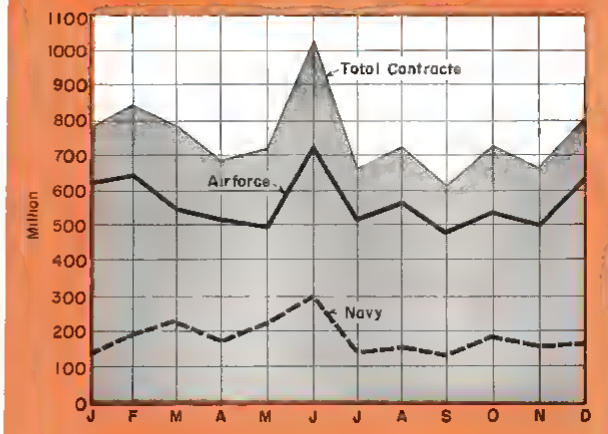
• **Sub-system manufacture.** The weapons system concept has introduced the sub-system requirement for large-scale development and production programs on major parts of the aerial weapons system such as air conditioning, auxiliary power systems, electronics and guidance and controls. This field is edging into new areas never before a part of the aircraft picture.

• **Nuclear propulsion.** The practicality and necessity for nuclear-powered aircraft is no longer questioned. Best evidence of this is the recent USAF decision to build a $12-million atomic engine research laboratory at Pratt & Whitney. And the nuclear airframe work at Convair. This field also is bringing in a wide variety of manufacturers never before involved in aircraft production.

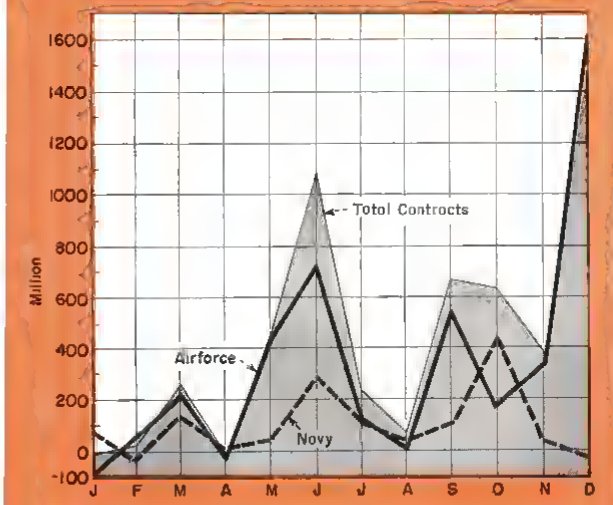
• **Human engineering.** This is a major new field that is just beginning to have an impact on the aircraft industry. It will develop new facets to old firms and create new firms.

• **Armament.** This is a rapidly expanding field both for aircraft and missiles that is drawing new industrial organizations into the aerial weapons system de-

Expenditures for military aircraft in 1954



Net obligations for military aircraft in 1954



velopment and production

• **Test equipment** This is a rapidly growing new phase of the aircraft industry dictated by the growing complexity of aircraft and the inability to flight test missiles before their combat firing Requirement for production line and combat-unit field test equipment for new aerial weapon systems and their components is growing at a rate faster than existing industry can handle it

• **Astronautics.** The exploration of space already has begun by the military and this is a serious, important phase of the aviation industry's future, not just a subject for science fiction and TV kid programs Not much is predictable in this field except that it already exists and will grow into a major segment of aviation effort

Production and Related-Worker Employment

(in thousands)

	U. S. AIRCRAFT INDUSTRY				
	Aircraft	Acft. Engines and Parts	Props and Parts	Other Acft. Parts and Equipment	Total
1954	343 2	105 9	11 5	89 8	550 5
1953	347.8	126.5	13 2	89 3	576 8
1952	311.6	98.8	10.4	62 7	483 5
1951	232 3	63.7	7 6	38 3	341 9
1950	138 9	40.0	5 5	22.1	206 4
1949	130 8	38.6	5 5	19.8	194.7
1948	116.1	35.0	5.1	17 3	173 6

Total Employment

(in thousands)

	U. S. AIRCRAFT INDUSTRY				
	Aircraft	Acft. Engines and Parts	Props and Parts	Other Acft. Parts and Equipment	Total
1954	497.8	166 8	16.1	125 2	805 6
1953	479 1	177 3	18 0	115.9	790 3
1952	425 9	138.8	14 5	81.6	660.7
1951	313.3	90 8	10 8	48.8	483.6
1950	188 4	55 8	8 3	29 3	281 8
1949	175 3	53.5	8 2	27 0	264 1
1948	158 0	48.6	7 7	23 3	237.7

Average Hourly Earnings of Production Workers

	U. S. AIRCRAFT INDUSTRY				
	Aircraft	Acft. Engines and Parts	Props and Parts	Other Acft. Parts and Equipment	Total Industry
1954	$2 08	$2 09	$2.09	$2 07	$2.08
1953	1.99	2.03	2 03	1 99	2.00
1952	1.87	1 98	2.05	1.88	1.90
1951	1.75	1.89	1.93	1 80	1.79
1950	1.622	1.696	1.743	1 698	1 644
1949	1.548	1.603	1.630	1 611	1 567
1948	1.465	1 550	1 565	1 551	1.493

SOURCE Bureau of Labor Statistics

Equipment Faces Supersonic Barriers

By George L. Christian

Growing Air Force emphasis on the weapons system concept, coupled with the rapidly growing number of USAF aircraft capable of supersonic speed in level flight, is imposing a host of new, extremely difficult problems on aircraft equipment suppliers.

To survey these problems, Aviation Week interviewed engineers and officials at Wright Air Development Center, the Pentagon, leading equipment companies and the plants of airframe manufacturers of supersonic planes.

"You can't just step on the gas and become supersonic," says one Pentagon official. "To build a successful supersonic plane, you have to start from the drawing board up and design everything in and on the plane for supersonic flight performance."

"The engine, airframe, and everything associated with it has to be an integrated weapon system aimed at successful operation through the increasingly wider speed ranges, from relatively conventional takeoff and landing speeds to ever-higher Mach numbers."

▶ **Germans Had It**—Probably one of the first instances when the problem of integrating aircraft equipment with the speed of the plane was recognized occurred with the world's first operational jet, the Messerschmitt 262.

When the Me-262 started flying, it was found that its high-velocity guns, coupled with the plane's high speed, made the projectiles travel so fast they became unstable. The fix: A low-velocity 30 mm. cannon was developed by Rheinmetall-Borsig to keep muzzle velocities low enough so the projectiles remained stable and permitted accurate gunnery.

▶ **Supersonic Posers**—Here are just a few of the areas where sustained supersonic flight is every day creating problems of continually growing magnitude.

• **Synthetic stability** has to be built into some supersonic aircraft. This is the only known means to allow the pilot to keep control of the plane at the wide speed ranges through which supersonic aircraft fly.

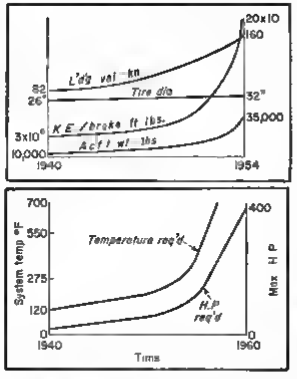
• **Vibrations** in completely new and different frequency spectrums are set up by today's large, high-thrust turbojet engines. These will have to be controlled with specially designed vibration isolators. Similar vibration problems are induced in surface controls at transonic and supersonic speeds. The problems are compounded because surface control vibrations are transmitted to flight control system hydraulic and mechanical components, where they can reach destructive proportions.

• **Wings have to become thinner** yet stronger as speeds increase. This creates difficult problems of design and what materials to use. Traditional aluminum is no longer good enough in some applications, so designers are turning to newer materials, such as titanium (whose handling, fabrication, etc., pose a whole new set of problems) and older metals, such as steel.

• **Flight and engine controls** must give better response or the results may be fatal. One spokesman compares the problem with the "hot rod" of the highway: "So often the combination of 'supersonic' car and a 'subsonic' driver results in a dead driver."

▶ **Supersonic Spawn**—It was not until the jet airplane ushered in the supersonic age that many of today's headaches became apparent.

At first they appeared as nebulous problems on the supersonic horizon. But the supersonic plane has been rushed off the drawing board and into the skies so quickly that the nebulous factors of yesterday have jelled into the real, still unsolved, problems of today. The point has been reached where many equipment manufacturers and system designers find themselves treading right on the edge of a variety of limits, such as temperature, design, etc., beyond which there is no clear way to progress without major new developments in techniques of how to do things, where to find new materials and how to handle them.



AIRCRAFT EQUIPMENT standards have become increasingly severe, as shown by these requirement graphs for wheel and brake (above) and hydraulic systems (below).

Aviation Week's survey has brought out that, although there is considerable disagreement about what are the really great problems and how to go about solving them, several factors stand out.

• **Specialization** is here in a big way, in spite of the Air Force's emphasis on standardization. We are drifting away from standard off-the-shelf pieces of equipment. One airframe design engineer explains it this way: "They won't fit and they won't do the job."

• **Reliability** of operation of airborne equipment and systems has become all-important. "The design of a hydraulic system fitting has become as important as the design of a main wing spar hinge fitting. With the advent of power hydraulic flight controls, failure of the former can have the same results as failure of the latter—loss of the airplane and possibly the pilot," says an airframe systems engineer.

• **Heat** is a problem that is wrapping itself around supersonic aircraft like a shroud. Says a USAF official: "We have just about run out of heat sink into which we can dump the temperatures generated in and by supersonic aircraft."

New equipment, based on concepts never before used in aircraft, is being developed to handle these problems which did not exist in the past.

▶ **The 'Yaw Barrier'**—A new barrier seems to be injecting itself between the old sonic barrier and the new thermal barrier—the "yaw barrier," as it is called by one airframe company making a supersonic fighter. An Air Force spokesman at Wright Field has said that a current USAF supersonic fighter could "yaw itself to pieces."

So yaw appears to be an added headache on the already imposing list of woes spawned by supersonic flight, and which teams of the country's top notch aircraft researchers, designers and test pilots will have to tackle, "sweat out" and solve.

Control

Supersonic aircraft have to remain controllable over very wide speed ranges. Aerodynamic instability over these ranges is probably one of the knottiest and most urgent problems shared alike by the Air Force, airframe manufacturers and equipment makers.

Just one factor in this regard is the tendency of a plane's center of pressure to move forward as speed increases. If the center of pressure moves ahead of the center of gravity, the air-

● MANUFACTURING

craft becomes unstable

▶ **Mach Box'**—One solution to the problem lies in what some technicians call a "Mach box," or the "synthetic stability" referred to above.

WADC experts say equipments composed of hydraulic, electronic and gyroscopic components have been integrated into a control system which is being tested in several experimental aircraft. Purpose of the system is to allow a human pilot to fly an aircraft by using standard cockpit flight controls which will operate the plane's surfaces through the integrated flight control system. With this system, WADC says, "the pilot can forget at what Mach number he is operating. As far as he is concerned, he is flying a nice, stable airplane, because the integrated control system automatically corrects for Mach and Q (dynamic pressure effect) within the limits of the plane's aerodynamic controls."

The Mach box will change the linkage (or gain) of a supersonic plane's flight control system to prevent stick forces from changing appreciably over wide speed ranges and avoiding sudden changes in control forces that may induce maneuvers violent enough to destroy the aircraft.

▶ **Feel System**—Still other problems crop up with supersonic flight.

An airframe engineer points out: "With supersonic aircraft, you get to the point where trailing edges 'crap out'—so you move the whole stabilizer.

"Then comes the control system, which is so critical that every part of it is tailor-made.

"And as critical a part of the control system as any on this particular (supersonic) aircraft is the feel system, which allows the pilot to judge how much force he is applying to the surface controls. If it doesn't work, the pilot loses his 'point of reference,' so to speak; if it jams, movement of the control system is restricted or becomes entirely inoperative, if it malfunctions, the pilot can apply forces which are abrupt enough to break the airplane. That is why we take such great care to make sure the feel system behaves."

Transonic speeds also create vibration difficulties in surface controls. In the transonic region, according to an airframe engineer, you do not know in what direction aerodynamic forces will operate. This eliminates aerodynamic boost as a means of activating surface controls and makes hydraulic actuation desirable.

"If you can grab hold of and hang on to a surface control with a good hydraulic system, at least you know which way the control will move," says one engineer.

Designers of supersonic aircraft are worried about buffeting surfaces. Buffeting is fed back to the control system. This must be "dead"—not resonate at any frequency that might be encountered in flight. If the control system should be in phase with flight surface-induced vibration, amplitudes could increase to the point of destruction.

▶ **Flying High**—On top of supersonic flight problems are added those of flying at extreme altitudes, where air is very thin—70,000 ft. and over.

A WADC spokesman puts it this way: "How do you create atmosphere and maintain temperature control when an airplane is operating at altitudes where there is no air?"

It is possible to carry vessels to supply cabin air when aircraft run out of outside air. But then, to conserve the air, it should be recirculated and the carbon dioxide given off by the crew removed. This means the development of a field of equipment completely new to the aircraft industry—a recirculating system which will take air out of the cabin, regenerate (purify) it and pump it back into the cabin.

Aircraft controllability becomes difficult at extreme altitudes, because aerodynamic control surfaces have nothing to bite into (probable answer will be to use deflecting jet air streams). And automatic control of flight becomes al-

most impossible because there is very little air to measure and therefore little pressure in the pitot system to tell the Mach box the plane's speed.

For the same reason, Mach meters, altimeters and rate-of-climb indicators become excessively sluggish at extreme altitudes, making the pilot's job of controlling the plane very difficult. Wright Field officials say a major effort is needed to develop air pressure instruments which will work briskly at altitudes of 70,000-80,000 ft.

►**Specialization**—The inefficiencies of specialization are apparent—lack of interchangeability, large stocks of different units, heavy transportation and logistics problems, training and maintenance headaches. But the demands of high-speed aircraft preclude the use of the old-fashioned off-the-shelf pieces of equipment which, a few years ago, could fit and do a good job on half a dozen aircraft ranging from fighters to transports to bombers.

On highspeed aircraft, especially those built under the weapons system concept, the equipment has to be tailored to do a highly efficient job on a very specialized airplane. To do this, the unit must be designed from the ground up to do just the job required of it on a particular plane.

"We are less and less able to accept a compromise unit and do the job required," says one engineer. Another puts it this way: "A piece of equipment that is best for one aircraft is not necessarily best for another."

A third sums it up: "If we accept standardization, we accept inefficiency."

►**Use Every Inch**—Another philosophy which counters standardization is the "maximum density" concept, where every cubic inch of waste space in an airplane is made productive if possible. This means that a piece of equipment has to be tailored to squeeze into a given, specialized envelope of strictly defined size and contour. Result: "What will fit on Lockheed won't fit on Grumman."

The degree of specialization required is underlined by this statement by an Air Force officer speaking of an expansion air turbine, "Standardization of the turbine between two different highspeed aircraft proved impossible although the planes are powered by the same jet engine (which supplies bleed air to run the turbine). Performance differences between the aircraft demanded tailor-made turbines in each case."

Reliability

Another dominant theme of the highspeed airplane is reliability, not only of equipment but of the systems they feed.

►**Everything Vital**—Reliability is needed not only in one particular system.

Take one supersonic fighter flying today. Failure of any one of three systems—hydraulic, electrical, pitot—could lead to loss of the aircraft. The plane has hydraulically actuated power controls. These are linked to an avionic computer acting as a Mach box which is fed by the plane's electrical system on the one side and pitot system on the other. Therefore, in the event of complete failure of any one of the three systems (including their alternates), the plane would no longer be controllable.

A hydraulics engineer told AVIATION WEEK: "As soon as hydraulically powered controls became mandatory because of unreasonably high stick forces, we were faced with the requirement of designing a hydraulic control system with a reliability equivalent to that of a mechanical linkage control system."

A pneumatics engineer brought in the demands of the guided missile program: "The missile boys are really telling us what reliability means. Although our standards have always been such that our equipment has been used on passenger-carrying and military piloted aircraft for years without question as to its reliability, the missile people demand a degree of reliability heretofore unheard of."

►**New Techniques**—Because equipment or system failure could have such dire results, new techniques have had to be evolved to assure continuous supply of such services as hydraulic pressure and electrical current, at almost any cost.

Among reliability techniques now in use on some of our most modern aircraft:

• **Parallel hydraulic systems.** Replacing the classic idea of a main hydraulic system with an abbreviated emergency system to perform such services as extend gear and flaps and operate brakes is the parallel hydraulic system. This consists of two independent hydraulic systems with separate pumps, reservoirs and lines, which operate continuously to supply power to all hydraulically operated services on the airplane.

In case one system fails, the other, being in operation, takes over instantaneously. Although failure of one system approximately halves the available hinge moment available to the pilot for controlling the airplane, he is still able to fly it.

• **Emergency air-driven equipment.** A problem, particularly on single-engine aircraft, is powerplant stoppage such as might result from a flameout. If the engine stops, so do all the engine-driven accessories, including hydraulic pump, generator and/or alternator.

To keep the hydraulic and electrical

systems operative, designers have gone to ram air-driven turbines to power emergency hydraulic pumps or generators. At least one designer, to avoid having to carry both a hydraulic pump and a generator out in the airstream, uses only a generator. This supplies current to the plane's electrical system and to an electric motor-driven hydraulic pump.

Pneumatic system compressors are usually electrically driven also. Thus, as long as the aircraft has forward motion, energy is available.

Cooling

Heat is becoming an almost universal bar to supersonic aircraft, their equipment and systems. One exception, according to a leading equipment manufacturer, is in the field of avionics. Here, the growing substitution of cool-operating transistors for heat-generating vacuum tubes is helping to alleviate heat problems.

• **Hydraulics.** An airframe hydraulics engineer comments that his department is on the verge of serious difficulties with metals, packings and hose because of high temperatures.

The rapidly disappearing heat sink creates a poser, the engineer says. "In our supersonic aircraft, it is no longer practical to cool the hydraulic equipment with ram air because at the speed our plane flies the air's temperature is up around 200F, which allows too little temperature differential to be effective."

• **Corrosion inhibitors** in hydraulic fluid (MIL 5606) tend to boil off at temperatures exceeding 200F (some technicians feel that the fluid is acceptable up to 275F). Result is that the fluid tends to corrode metal components of the hydraulic system.

• **Maximum-density concept,** the crowding of equipment, lines, wiring and structure into every available space in the aircraft, imposes severe problems on where and how to route hydraulic lines so they will avoid "hot spots." Supersonic skin temperatures aggravate the problem. So a hydraulic system designer seeks to lay out his system where it will not only avoid all hot spots and skin-generated heat, but also dump a little heat wherever feasible.

One possibility is use of fuel to help cool the hydraulic system. But fuel is already used to cool engine oil and "the engine people might not like us to heat up their fuel any more."

One airframe hydraulics engineer believes these approaches should be pushed to help alleviate heat problems:

• Up-grade all equipment associated with high temperatures.

• Make metals less susceptible to corrosion.

• Go to metal seals in static applications. Possibly Teflon or similar materials may help solve high temperature packing problems.

This engineer also notes the trend away from non-flammable hydraulic fluids towards high-temperature resistance, since no one has yet been able to make a fluid, usable in aircraft hydraulic systems, which combines the virtues of non-flammability and high-temperature resistance.

• **Electrical**—While the substitution of transistors for vacuum tubes is alleviating cooling problems in avionic packages, heat is a growing problem in electrical power generation, according to a WADC technician.

He cites this example. In an F-86D flying at Mach 0.85 at 40,000 ft., generator-ram air pressures of 40 in H_2O (minus duct losses) are experienced. These high pressures create sufficient heat to cause failure of the types of generators used until recently.

Another problem resulting from the high air pressures is that grease in generator bearings is siphoned out, causing failure. Now, new generators have been installed which can accept the conditions of being cooled by zero-Fahrenheit air at 40,000 ft. (where the rarefied air is only ¼ as effective as at standard conditions) and the bearings can withstand ram air pressures of up to 50 in. H_2O.

The WADC spokesman points out: "Up to now, generators have been designed electrically and mechanically with little thought to the thermal conditions under which the machines must operate. If designers would include thermal criteria from the moment the generator is first conceived—right from the drawing board stage of the machine, then we may get a unit which will be able to operate with ram air as a coolant up to speeds of Mach 1.5, where ram air pressures at 50,000 ft will be on the order of 100 in. H_2O.

"The next step may be to install a sonic venturi in the intake cooling air duct which will allow ample cooling air to pass at air speeds below Mach 1.5. But as the aircraft begins to exceed this speed, the venturi will reduce ram air pressures as they become destructive.

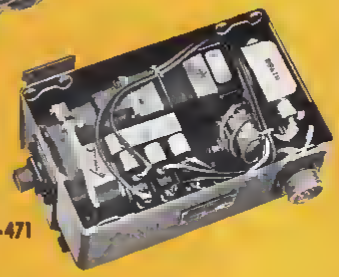
As aircraft speeds increase still further, there are other alternative cooling methods, according to WADC. Among the basic means are heat exchangers. These units are the most flexible because they could use air, fuel or a coolant to dissipate the heat, and they could be built and installed so that air could be used as a heat sink for normal cooling but would be bypassed and an evaporative cooler substituted for short, "dash" periods. When the plane slows down after the dash, air is again used.

SPECIAL motors and actuators for aircraft and guided missiles can best be made by *SPECIALISTS* who make nothing else!

For years EEMCO has concentrated its entire effort on the design, development and testing of prototype models and in meticulous quantity production of motors and actuators for the nation's leading airframe manufacturers. Shown here are but a few examples of EEMCO's products. And because EEMCO is constantly searching for new and more efficient materials with which to improve performance and reduce weight of its products, as well as developing new processes for producing them to exacting tolerances, it has kept pace with today's spectacular development of super-sonic aircraft and missiles.

TYPE D-357

TYPE D-665



TYPE D-471

TYPE D-632

TYPE D-638

TYPE C-1180

TYPE D-649

TYPE R-149

MOTORS

TYPE D-632 Small motor for fans, blowers and pumps or for many other uses where a light, compact unit with unusually long life is required. Only 6½" long, 2¼" diameter, weighing but 23½ ounces, 50 watts continuous at 7500 r.p.m., 40° centigrade rise at sea level operation and normal ambient, brush life at least 2000 hrs., designed to meet ANM 40 specifications. Speed can be varied by changes in winding and/or lamination stack length. Wound for 28 volt D.C., it can be wound for either 110 volt A.C. or D.C.

TYPE D-638 400 cycle 6½ HP A.C. motor for intermittent duty, made to drive a hydraulic pump on a guided missile. Duty cycle is 3.0 seconds at 6.5 HP with 2250 r.p.m., 15.0 seconds at 1.5 HP. Has continuous rating of 5 HP at 2300 r.p.m., 15.8 amperes, 200 volts. Weight 17½ lbs.

TYPE C-1180 Stand-by motor for horizontal stabilizer. Has a duty cycle of 50 seconds on, 3 minutes off. Rated 13,000 r.p.m. on 25 volt D.C. at 21 amperes, with 0.5 HP output. Has 2 inch stack length. Weight 4¼ lbs.

ROTARY ACTUATORS

TYPE D-357 EEMCO designed canopy actuator develops 50 inch-pounds at 280 r.p.m. operating on 28 volts D.C. in intermittent duty. Gear ratio is 40 to 1. Unit includes magnetic clutch and brake and radio noise filter. Stall torque is 300 inch-pounds maximum. Weight 4¾ lbs.

TYPE D-665 Designed as a trailing edge actuator for jet fighters. It has a normal peak load of 28,000 inch-pounds and a total angular travel of 30°. Speed is 675 r.p.m. with an average load of 14,000 inch-pounds on a 28 volt D.C. system (187.5 amps). Ultimate static load is 77,000 inch-pounds. Weight 25½ lbs. Design incorporates auxiliary power take-off and non-jamming end stops.

TYPE D-471. Flexible universal rotary power package combines in one small container motor, radio noise filter, magnetic clutch and brake, main reduction gear and auxiliary gears for driving adjustable limit switches, light switches and position indicator. It has a wide variety of possible adaptations utilizing flexible shafting to drive small rotary or linear actuators singly or in multiples. Dimensions are only 7½" x 4-7/16" x 2¾". Weight only 3½ lbs. Specifications may be varied to suit special requirements.

LINEAR ACTUATORS

TYPE D-649. This rugged linear actuator weighs 13¾ lbs., and operates with a stroke of 3-5/16" at 55 inch per second under a working load of 3400 lbs. normal tension and 6200 lbs. peak tension on a 28 volt D.C. system. Maximum static load is 18,750 lbs. It has a flexible shaft drive take-off, load limit switches, non-jamming end stops and a retraction step that adjusts to within ⅛ inch. With minimum expense and delivery time EEMCO's Type D-649 can be supplied for various loads, lengths of stroke, rates of travel and other characteristics.

TYPE R-149. This unique linear actuator is entirely self-contained, the motor, clutch, planetary reduction gear and limit switch are all enclosed within the smaller inner cylinder. Type R-149 has an unusually long stroke of 9.625" at 3" per second under a normal load of 4000 lbs. on a 28 volt D.C. system. Maximum operating load is 8000 lbs., maximum static load 15,000 lbs. Compact Type R-149 has adjustable load limit switches, non-jamming end stops, and a motor that shuts off automatically when end stops are reached or load exceeds a pre-set limit. Weight 10 lbs., 5 oz.

PROJECT ENGINEERS *Please Note!*

EEMCO has designed, developed, tested and manufactured scores of motor and actuator models at various sizes, capacities and specifications. Perhaps one of these can solve a problem that now confronts you. Use of it might save precious design, development and testing expense and delivery time. In fact, even modification of a present EEMCO model could save considerable time and money versus establishment of a completely new unit that you now feel must be designed, developed and tested before production and delivery can begin. Please consider this possibility. Your inquiry is invited.

EEMCO

Electrical Engineering and Manufacturing Corp.

4612 West Jefferson Boulevard, Los Angeles 16, California
Telephone REpublic 3-0151

Another advantage of heat exchangers is that many a.c. generators are driven by constant-speed hydraulic drives containing their own oil cooling systems, which could be tapped to supply a cooling medium for the heat exchanger with little weight or space penalty, says the WADC technician.

Still another means of dissipating heat is to use a specialized form of heat exchanger—evaporative cooling, he says. Such units do not require a heat sink, they are independent of ambient temperatures and they are relatively efficient as heat transfer mediums. But they do have a drawback, he cautions—the space and weight penalty of carrying water (or other evaporant) make their use almost prohibitive except for short flights or 'dash' conditions.

Among important improvements which will have to be accomplished to make electrical systems compatible with the temperatures of highspeed flight are significant increases in the temperature resistance of insulating materials, lubricants and bearings, say WADC technicians.

• **Pneumatics.** Problems bothering pneumatics people are much the same as those which beset the hydraulics engineers—seals, O rings, packings.

The engineer of a large pneumatics equipment manufacturer says "Heat problems as far as pneumatic systems are concerned have gone out of this world." He adds that "a partial answer may lie in the use of Kel F or Teflon as packing materials, but then you run into the difficulties of how to form, how to machine and how to use such products."

One consideration that pneumatics technicians do not have to worry about is deterioration of air, in contrast with hydraulics people, who have to watch against deterioration of hydraulic fluid. But pneumatics engineers have a worry all their own—where to find enough air at altitudes above 70,000 ft. To date, the answer has been to supercharge the air going to the pneumatic system compressor by bleeding the jet engine's compressor section.

Still another problem posed by heat is the need for highly effective and very accurate temperature control of equipment, to keep it from getting out of calibration or malfunctioning completely if the temperature in which it is operating strays even slightly from relatively strict limits.

The pneumatic system aboard "hot" aircraft may well have to look to some sort of liquid or evaporative cooling crutch to stay within reasonable temperature limits.

• **Refrigeration.** The heat problem has brought the general field of aircraft refrigeration into the forefront.

There are several methods of cooling an aircraft.

One method is to pre-cool a plane before flight and keep it cool during flight with a storage cooling system using a refrigerant such as dry ice. Such a system can be light and removable.

Insulation to retard the penetration of heat is another approach to keep the interior temperature of an airplane at acceptable limits.

"However, the most prevalent system and the one which will be with us for years to come is air-cycle refrigeration, using an expansion air turbine as a cooling source," according to an WADC official.

Since the heart of an air-cycle cooling system is an expansion turbine, a program is currently under way to broaden the efficient performance range of these machines to make them more acceptable to wider ranges of aircraft performance. Two approaches to this problem are use of variable inlet guide vanes to the turbine to regulate amount of air impinging on the turbine's blades, and study of the turbine's blading configuration with a view to improving the machine's overall efficiency.

The expansion turbine's high rotative speed—up to 100,000 rpm—coupled with high bleed temperatures—over 700F—conspire to cause failure of even the best of bearings.

• ENGINEERING

For engineers, there is always an Age of Peril.

The work they do lies in gray areas between knowledge and ignorance; they bridge the gap between light and darkness.

On their skills depend the lives of pilots and crew; on their success or failure hang the outcomes of battle.

From their sliderules and computers come the myriad shapes of supersonic flight, of fat freighters pregnant with cargo, of sleek bombers with atomic retaliation in their bellies.

Security in an age of peril rests in the hands and on the shoulders of engineers.

U. S. Research Aircraft

Manufacturer and Address	Designation	Seats	Number, make, model, and power of engine	Maximum speed (mph)	At altitude (ft.)	Gross weight (lb.)	Span	Length	Height	Remarks
Bell Aircraft Corp. *Buffalo, N. Y.*	X-1	1	1 RMI-6000-C-4 @ 6,000 lb. t.	1,000	60,000	13,000	28'	31' 0"	10' 10"	First to exceed Mach 1 10-14-47
	X-1A[1]	1	1 RMI XLR-11 RM-5 @ 6,000 lb. t.	1,650[4]	90,000+[4]	16,000	28'	35' 7"	10' 6"	Turbine driven fuel pump.
	X-2	1	1 C-W throttleable rocket	2,250*	100,000*	—	—	—	—	Stainless-steel swept wings, K-Monel fuselage, tail.
	X-5	1	1 All. J35-A-17 @ 4,900 lb. t.	—	—	9,850	33' 6"[2]	33' 2"	12' 2"	Variable-sweep wings. Transonic trials
Douglas Aircraft Co. *Santa Monica, Calif. El Segundo, Calif.*	D-558-I	1	1 All. J35-A-11 @ 5,000* lb. t.	650+		10,000*	25'	35' 1"	12' 2"	Set record of 650.6 mph. 8-25-47
	D-558-II	1	1 RMI rocket[3] @ 6,000 lb. t.	1,327[4]	83,235[4]		25'	42' 3"	13'	Wings swept 35 deg.
	X-3	1	2 West. J34-WE-17 @ 4,500 lb. t.[5]		—	27,000	22' 8"	66' 9"	—	High-speed, altitude research.
Northrop Aircraft, Inc. *Hawthorne, Calif.*	X-4	1	2 West. J30 @ 1,600 lb. t.	—	16,000	7,000*	26' 10"	23' 4"	14' 10"	Semi tailless sweptwing. High transonic tests.

* —Approximate
All. —Allison
C-W —Curtiss-Wright
RMI —Reaction Motors, Inc.
West. —Westinghouse
Lb. t. —Pounds thrust

[1] Other versions: X-1B, X-1D. Pilot ejection seat installed in X-1A. X-1D destroyed during tests, 8-23-51.

[2] Wings fully forward. With wings swept, span is 23 ft. 4 in.

[3] Originally fitted also with one Westinghouse J34 to provide takeoff power and climb to altitude. Turbojet later removed from at least one of three Skyrockets to make room for more rocket fuel. Plane then carried aloft in belly of Boeing P2B-1S Superfortress.

[4] This figure achieved during course of high-speed or high-altitude trials.

[5] Originally 2 Westinghouse J46 jets of approximately 7,000 lb thrust each scheduled for X-3.

Researchers Slip by New Mach Hurdles

Grumman's F9F-9 Tiger breezed easily through Mach 1 late last summer to mark a turning point in the understanding of the science of aerodynamics.

Its performance underscored an achievement of great importance. No longer is it necessary to use brute force to batter down the drag rise and blast through sonic speed.

Instead, drag can be reduced to a point not believed possible just a few years ago. By careful attention to detail design, engineers have been able to lower the peak of the drag rise near sonic speed.

► **Lower Power, Higher Speed**—The tiny white Tiger is thrust through the air by a medium-powered Wright J65 Sapphire, putting out somewhere between 7,000 and 7,500 lb. of thrust. Yet the Tiger has touched the same Mach marks reached earlier by North American's F-100 and Douglas' F4D, both powered by the 10,000-lb.-thrust Pratt & Whitney Aircraft J57.

Its performance was later matched by the Convair F-102A, modified from the original lines to include the same design ideas that boosted the Tiger over the sonic fence. In the Convair case, these ideas made the difference between an airplane with a subsonic speed limitation and one that could make its original supersonic performance guarantees.

Thus, design aerodynamicists have been handed a speed dividend measured in tenths instead of hundredths of a Mach number. They've been able to slice total drag to the bone, instead of whittling away a tiny bit of coefficient at a time.

► **Profit and Loss**—The scales were balanced by tragedy: the death of George Welch, flight testing a late model of the F-100. While making symmetrical pull-ups at high speeds, the plane outran the available knowledge of its designers. It yawed and pitched simultaneously, broke up in the air, and Welch died as a result.

The F-100 had crossed over the gray area of engineering knowhow into a region where there was no specific knowledge. Now, largely as a result of the intensive accident investigation made by North American, engineers know what happened, and they know how to prevent its happening again—at that Mach number.

The F-100 was the victim of an unexplained aerodynamic phenomenon, a dynamic condition triggered by something corresponding to a third- or fourth-order term in the equations of motion. One result of the accident will be increased demands on the big computing machines for solution of the complicated dynamic equations down to terms of the Nth degree.

But you never solve fully the problems of highspeed flight—you just delay them to a higher Mach number. There isn't enough basic information available to guarantee a solution in advance to every possible problem that can be posed by the cleavage of air at supersonic speeds.

That is where the pinch is going to be.

► **Limited Time**—With every windtunnel in the country operating at full blast, in some cases round the clock, the schedules of tests are still falling way behind the loud demands of the design groups.

There are two general reasons, aside from the physical impossibility of providing enough tunnels and technicians to handle the maximum demands of designers. First, a designer always asks

GRUMMAN F9F-9 TIGER

for more information than he hopes to get, he does it for bargaining purposes, for establishing a priority, and because he really doesn't know what to ask for Second, as soon as the first test points come in, he realizes that the trend is different from what he expected and so adds some more to his schedule Thus, demand for data continually outraces supply from tests

It is not generally realized that the number of transonic windtunnels—which must fill the biggest gaps in our knowledge—is pitifully small Most supersonic tunnels are so tiny that the models they test don't have space for much instrumentation About the best the designer can hope for is trend data, points that are scattered but lead along a general line

Even the many low subsonic tunnels have not produced—for one reason or another—the kind of data they can most usefully prepare Stability problems at the lowspeed end of the flight spectrum are today the same problems encountered during World War I, and yet perhaps no other subject has been so vigorously pursued in the tunnels than that of lowspeed static stability

▶ **Fast Fixes**—Contemporary airplanes show external evidence of design changes made in the light of flight test and windtunnel knowledge

Thin wings, regarded as essential in highspeed flight, brought with them a host of lowspeed problems High wing loadings, for speed and drag reduction, meant inferior altitude performance Sweepback brought unusual flow patterns to reduce aileron and flap effectiveness and to drop available lift coefficients well down the scale

For these reasons, today's wings show jagged outlines, discontinuous leading and trailing edges, sharply cambered noses Boundary-layer fences channel the wing flow aft instead of spanwise on swept surfaces Leading edge extensions and vortex generators change the flow character to reduce drag and increase lift coefficients Cambered leading edges soften takeoff and landing and tighten the altitude turns

These are all tricks in the aerodynamicist's bag, generally used after the original design has developed its limitations in flight test

▶ **Weathervanes and Steering**—If you had to name a single area where there are the greatest gaps in current knowledge, stability and control would be as close to right as you could be (Cynical aerodynamicists say you'd always be right with that statement)

The problems of stability have been aggravated, like every other flight problem, by the highspeed airplane Not long ago, most of the mass of the airplane was concentrated around its center of gravity. Fuel, pilot, engines and armament formed a high-density chunk

near the quarter-chord point of the wing

Dynamic theories of the time could cope adequately with such designs, because they assumed a point mass concentrated at the CG, and this was close enough to fact to introduce only minor errors

Then came the supersonic designs, with long engines, afterburners, tons of avionic and other systems equipment, and gallons upon gallons of fuel To keep the drag low, the cross-section of the fuselage was whittled down until it could just accommodate a man or an engine, whichever was the governing dimension

This meant stringing the rest of the weight along the fuselage, in a high density package as long as it could reasonably be made Mass distribution was no longer even approximately a point, and the nose was far ahead of the wing Those two factors were de stabilizers in highspeed flight

The mass distribution meant that damping in yaw and pitch was not as strong as it had been The distant nose generated considerable lift or side force of its own as it approached and passed the Mach mark These de stabilizing influences had to be countered with more stabilizer area or force, which meant more tail area, all-flying tails, slab tails, and all power-operated surfaces

This is a major concern now, because a supersonic airplane isn't much good if it can't be controlled and is dynamically unstable

Temporary troubles with the F-100 have colored the research programs at NACA and elsewhere But the major area to study is stability and control

Because there has been concentrated effort on what is generally called "design aerodynamics"—studies of performance—stability and control studies have suffered

Much testing time needs to be devoted to finding stability derivatives—the rates of change of the stability coefficients around all three axes as they change with angles of attack or roll or yaw.

▶ **Checks and Balances**—So the aerodynamicist, today as always, works in an area where he is continually running out of knowledge The lucky among them are those who have enough experience to be able to extrapolate well and faithfully

Extrapolation is the fertile parent of error, as someone said during the Comet inquiry But he might have added that extrapolation also produces considerable progress

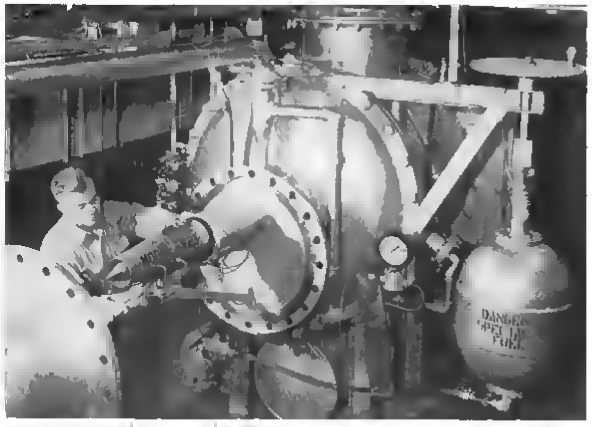
In aerodynamics, the secret is to know which way the curve is going to go The designer with the best crystal ball is the successful one.

Research Extends Propulsion Frontiers

Propulsion progress is the key to further advance in aeronautical development. Without this progress, there can be no real advances in probing the unknowns of the air.

No longer can a "standard" powerplant be adapted to a wide scope of services embracing a broad band of operating conditions. Each member of the new range of engines crowds its counterparts for a place in the power spectrum. At the same time, it brings a host of problems for the researcher, designer and manufacturer.

TURBINE ENTRY simulation duplicates high temperature internal flow conditions.



RAMJET MODEL is mounted in altitude combustion test stand at NACA Lewis lab

Of major importance in the propulsion picture are the turbojet, turboprop, turbofan, ramjet, rocket and nuclear engine and some variations of these.

Some are established production items, some are under development. All are under study. The reassuring thought is that, generally, emphasis has been placed on first things first—at least in this country—and that's why the simple turbojet still holds the brightest spotlight.

Turbojets

In any development, certain problems are not solved until after the product is in wide scale use. These problems have been met with the turbojet because of the tremendous number of units that have been made and used, while concurrent development goes on all the time.

►**Limits Recede**—Because the numbers of pure jets in comparison to other types has been so overwhelming, it is safe to assume that this predominance will continue for some time. Also, military applications will likely continue to account for the big bulk of usage.

The speed limitations of the turbojet configuration in relation to Mach number of aircraft are not yet in practical sight. The more the turbojet is developed, the higher is the speed seen for its military practicality.

Previously, M-1.5 was considered the limiting speed for the turbojet. Now, a value of M-2 is feasible. Development indicates that there is no near point for which it can be said with reasonable certainty that "turbojet usefulness ends here."

When it will be more advantageous to go to a simpler engine, such as the ramjet, will depend in large measure on the ability to lick the high-temperature problems which will pile up long before the speed capabilities of the turbojet end.

Included in the continuing development of the turbojet is a range of power from small to very large. This indicates a considerable future of work on these engines. Considering the attention this general classification is getting, there is no comparable situation with the turboprop, turbofan, ramjet, or rocket.

Turboprops

Even though the turboprop engine is much in the limelight today, its future is somewhat uncertain, in the opinion of many industry observers.

It is a more difficult engine to bring along basically, introducing new complexities of gearing, propellers and controls. Some very real problems are involved.

STACKS for steam and silence jet skyward from Wright Aeronautical ramjet facility.

A peculiar quirk is that in the process of developing this engine, the turbojet (the basic scheme) is again receiving additional refinement.

►**In-Between Engine**—With respect to performance—the speed and altitude where the turboprop would be used—the engine stands somewhere between the reciprocating powerplant and the turbojet.

The general lack of keen enthusiasm for the turboprop has handicapped its development, made it more difficult to get funds for bringing the type along. In the next couple of years, the situation will be much clarified as a result of the resurgence of interest in the engine.

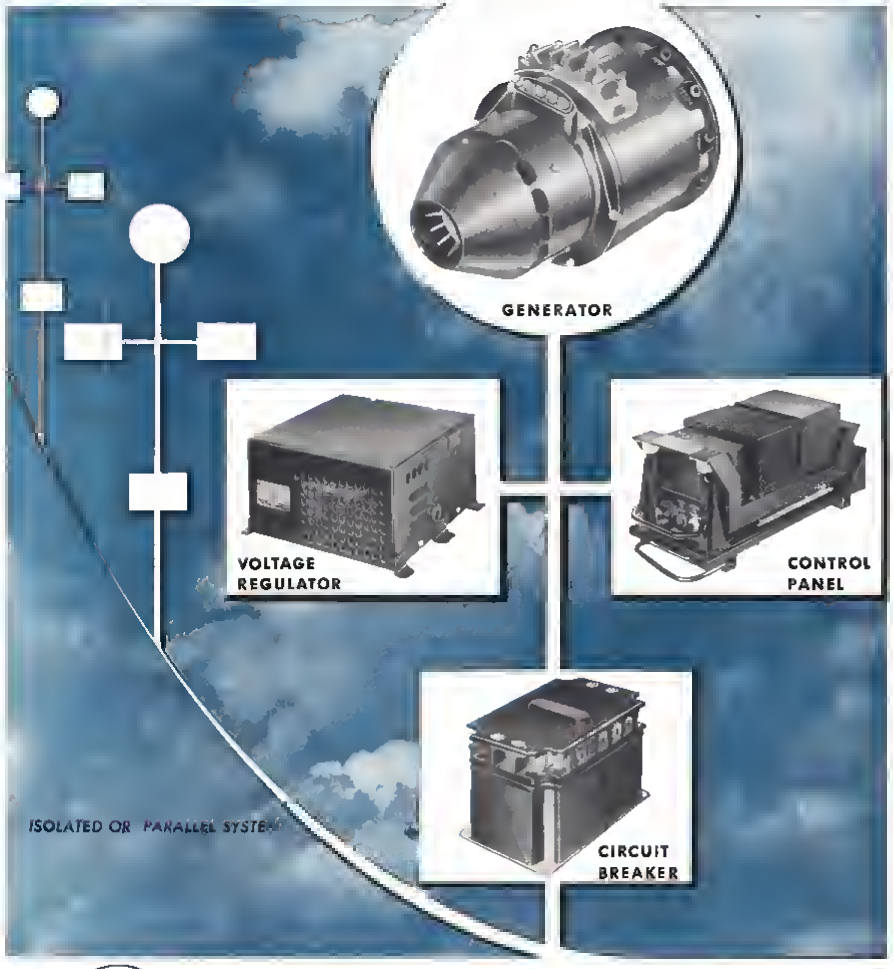
Britain has pushed strongly with the turboprop. A British squadron of turboprop planes—Westland Wyverns—is now in carrier service. In the picture, in varying degrees in Britain are the Armstrong Siddeley Mamba, Double Mamba and Python, the Bristol B.E. 25 and Proteus, the Napier Eland, and the Rolls-Royce R.B. 109 and Dart.

►**Small and Large**—Here in the U.S., a number of turboprop engines are more or less on the scene—the Allison T40 and T56, the Pratt & Whitney T34 and T57, and Wright T47 and T49. Smallest is the 3,750-eshp T56; the largest (T47 and T57) may be conjectured to be in the region of 12,000-15,000 hp.

Thus, the turboprop engine may be big or it may be small (as the Dart), but the immediate trend is believed to be toward large units (except for helicopters, where the variation of the turboprop will be a shaft turbine engine).

Incidentally, the helicopter is seen as offering a tremendous field for the shaft turbine unit, because inherently

A-C SYSTEMS FOR AIRCRAFT



JACK & HEINTZ

...a report from JACK & HEINTZ

Wide range of a-c systems... result of expanded J&H Generator line

Jack & Heintz now offers the aircraft industry complete alternating-current systems and components "tailored" to meet the demands of tomorrow's high-performance aircraft.

With the expansion of its a-c generator line and extensive experience in the development and production of a-c control panels, regulators and other auxiliary components, J&H can now supply a-c systems ranging from 3 through 120 kva. These systems are capable of isolated or parallel operation.

MAJOR SYSTEM COMPONENTS

GENERATORS: Designed to MIL-G-6099 and applicable drawings, J&H a-c Generators are among the smallest and lightest yet developed. Available models include cooling by blast air, oil or vapor

Important features include:

Light weight* • High efficiency*
Low harmonic content* • Phase balance*

*Better than required by MIL G-6099 and applicable drawings

VOLTAGE REGULATORS: Designed to MIL-G-6099 and applicable drawings, J&H Regulators are of the static-magnetic-amplifier type. Weighing only twelve and one-half pounds, the regulators feature a magnetic reference eliminating the use of electronic tubes. Provision is made in all regulators for reactive load division function.

CONTROL PANELS: Designed to applicable USAF and Navy specifications, J&H Panels can also be built to special requirements. They can operate either from the d-c bus or independent of it.

J&H Panels include any or all of the following functions (which can be supplied as individual components, if desired):

Generator control relay • Over-voltage protection† Undervoltage protection • Phase-sequence protection • Under-speed or under-frequency protection Anti cycling • Power indication • Field flashing Special interlocking

†Overvoltage relay is insensitive to acceleration forces.

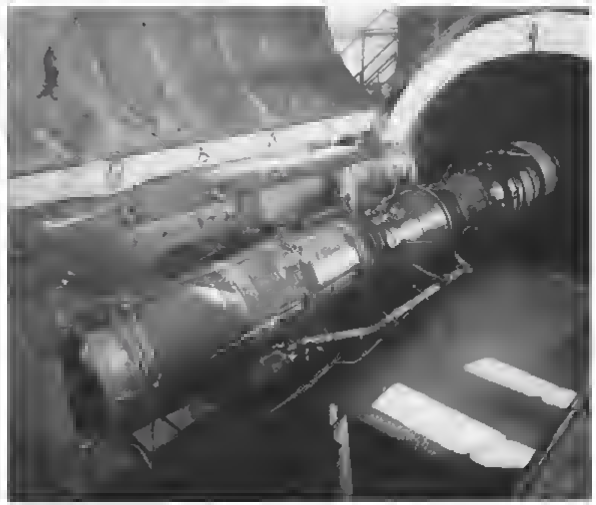
CIRCUIT BREAKERS: Designed to MIL-C-8379, J&H Circuit Breakers have the following outstanding features which make them exceptionally well suited for use on high performance aircraft.

Balanced rotary latch
Direct solenoid-actuated contacts
Nonetrical adjustment of interlock contacts
Easy inspection of main contacts

OTHER COMPONENTS: In addition to the panel functions which can be supplied as individual components, Jack & Heintz has developed transformers, reverse power relays, phase sequence relays and other auxiliary a-c system components.

Jack & Heintz engineering personnel and manufacturing facilities are geared to undertake design and production of complete a-c systems or individual components. We invite your inquiry. Write Jack & Heintz, Inc., 17635 Broadway, Cleveland 1, Ohio.

Rotomotive AIRCRAFT EQUIPMENT



FULL-SCALE TESTS of jet engine in NACA altitude windtunnel prove performance.

this aircraft is a short-range plane. The weight of the engine would be sufficiently lighter than a corresponding piston engine to more than make up for the higher fuel consumption it would show over the piston plant.

Weight of the shaft turbine engine should be no more than one-third to one-half that of a piston engine of the same power.

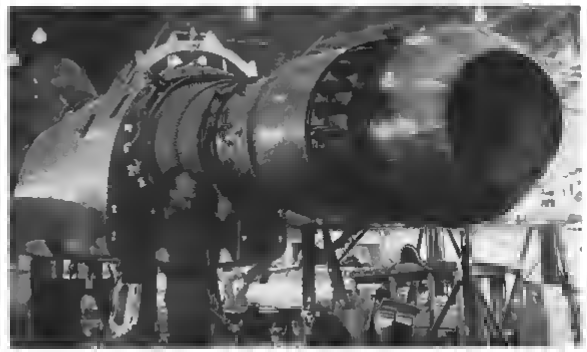
▶**Military Turboprops**—There is going to be a definite spot for the turboprop-powered plane in the subsonic regime—it is only a question of how big this field will be.

After a long period of indecision, the military is beginning to appear as the largest proponent of turboprop aircraft, particularly in the transport field. Now in production, or planned for this status, are the Lockheed C-130 powered by four T56s, Convair R3Y powered by four T40s, Douglas C-132 with four T57s, and Douglas C-133 with four T34s.

In the testbed category are the Convair C-131C with two T56s, the Lockheed R7V-2 with four T34s, Lockheed YC-121F with four T34s, the Douglas C-124B with four T34s, and the Boeing YC-97J with four T34s. Also, a Boeing B-47D is fitted with two T49s.

In the experimental category, there are the vertical takeoff craft—the Lockheed XFY-1 with one T40 and the Convair XFY-1 with one T40.

▶**Commercial TPA Aspects**—In the commercial turboprop transport field,



END PRODUCT: A production turbojet is installed in the rear of a fighter fuselage.

a mixed situation exists. The feeling one gets is that the airframe builder and the operator don't know which way to jump. The situation is confused.

Even though Capital Airlines is going to operate the Dart powered Viscount, the feeling is that this engine is a "toy" powerplant (equivalent to 1,600-1,700 eshp with residual thrust) in comparison with those in the picture here and soon to come.

The Dart doesn't show what can be expected or what troubles will be encountered with a big turboprop. In the same manner that a big piston engine magnifies the problems of a small one, the big turboprop multiplies the headaches of the small engine many times.

▶ **Price to be Paid**—Roughly speaking, a good turboprop would provide an economical aircraft about 100 mph. faster than the fastest available piston plane. Probably, a turbojet transport about 50 mph. faster than the turboprop can be provided with about 10% more direct cost per passenger-mile, and at an increased cost over this, a jet transport can be obtained which will give as high as a 575 mph. speed—about 100 mph. more than the economical turboprop transport.

The increase in direct cost may not be the deciding factor in the face of competition. Speed may be what tilts the scales.

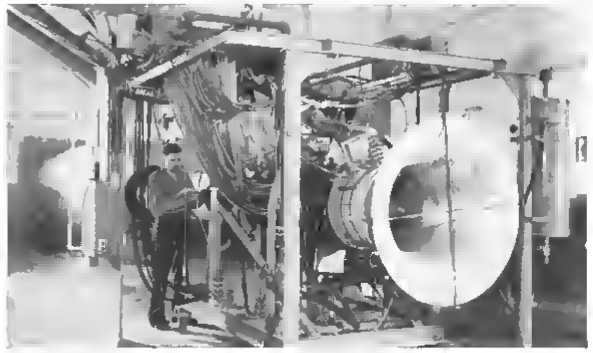
So long as the threat of the jet engine exists in the commercial transport category, it is going to take a lot of deliberation before someone builds a brand new turboprop plane. Of course, a turboprop engine can be adapted to existing or modified airframes for commercial use—both the Convair 340 and the Douglas DC-6 are under consideration.

In the matter of power, if the turboprop is going to be the equivalent of the turbojet engine available today, it will have to be in the 15,000-eshp class, and for commercial service there is no turboprop engine as close to readiness as is the 10,000-lb J57 turbojet in the Boeing 707.

Turbofans

The exact status of the turbofan engine is one of the big mysteries in the propulsion panorama. As a type it stands between the turboprop and the turbojet, just as the turboprop stands between the reciprocating engine and the turbojet.

▶ **More Work Needed**—Although very little work has been done in this country on the turbofan, many engine designers feel that it is no longer true that turbofan development need be retarded because of the emphasis that has been placed on other types of pro-



COMPRESSOR STUDY is made in sea-level static tests for component development.

pulsion. There is considerable enthusiasm for the engine, they say, and adequate engineering facilities are available for development.

What is needed to accelerate interest in this type of powerplant is some realistic procurement policies, it is contended.

One prime question is posed—are the improvements that the turbofan offers worth the development time and money necessarily involved?

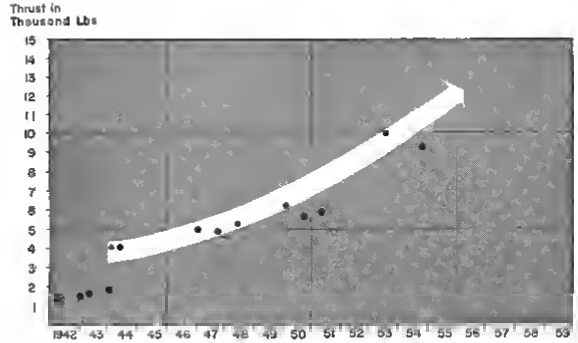
It would cost about $25 million to develop an engine through type tests. It would cost another $25 million for further development and getting the engine out on the market. This would be equivalent to an expenditure of $50 million for a production-type engine of any large configuration—turbofan, turbojet, or other types. At this point, development for growth has only started, and this growth is essential if the engine manufacturer is to get his money back.

This cost factor is another reason why an engine cannot be developed in this country for one application alone. The British can do it, it seems, because government support is frequently involved, as with the Conway bypass engine, specifically for the Vickers 1000 transport.

► **Thoughts for Transport**—For a transcontinental transport of 75-passenger, first-class configuration, with an over-500-mph cruise, the feeling in this country is that the turbofan is a standoff in operating cost with a good straight well-developed jet.

This transcontinental airplane's gross would be slightly less with the bypass turbofan engine, because the plane would be carrying less fuel. Also the turbofan engine would have a slightly greater takeoff power advantage. These two advantages would be set against the added complexity of the turbofan engine. In addition, the engine would involve more difficult accessibility.

An outstanding example of application for the turbofan would be in the Paris-New York run against, say, 80-90 mph headwinds. Here the turbofan begins to show off better—perhaps 5 to



THRUST VS. TIME curve shows increases in engine power since earliest jets.

7%—than the straight jet in direct operating cost. The airplane gross in this case is about 10% smaller in favor of the turbofan-powered aircraft, and the engine has a still larger margin of takeoff power. Again, these advantages must be balanced against the added complexity of the engine.

Therefore, the conclusion is that if the turbofan were equivalent to the turbojet in all respects—degree of development, reliability of manufacturer, experience with the engine, etc—it would be chosen as the favored powerplant. But the newness of the turbofan, coupled with the lack of previous military experience with it, would seem to bar its acceptance for commercial transport use in this country, although the British may put the engine into a military transport.

▶**Bomber Considerations**—The turbofan also would seem to be applicable to the longrange bomber, but there are qualifications. Future bombers will have a supersonic dash or strike (bomb run) and will use afterburners for this purpose. It is reasonable to believe that these strikes or dashes might be relatively long—that the pilot would have to "step on the gas" at a pretty fair distance from the target.

For a speed up to M-1.5 for the dash, the straight jet probably would be the better engine. Somewhere from M-1.5 to M-2 dash speed, the turbojet and the turbofan would be a standoff, roughly. From M-2 and up, the turbofan probably would show up as the better powerplant.

Afterburners

The afterburner has established itself solidly in the propulsion field. It is now considered a definite part of the jet engine, almost like the burner itself.

▶**Largest Part**—The afterburner is becoming the largest part of the power unit, in fact is determining the size of the engine envelope. In a good high-compression engine, addition of an afterburner may double the power of the basic engine under the right conditions.

As with other equipment, the afterburner is becoming more and more complex. The trend is to squeeze more power from a smaller package, and operation at higher altitudes and speeds will pose additional problems.

Concentration on afterburner development will be for engines for very high speeds. It is probable that the afterburner will be installed on every military engine of the future—even though fuel consumption is high, this is considered a cheap method of getting big additions of thrust.

It is not likely to be developed for small turbine engines, although some

may be developed for some small turbine applications in missiles

Small Turbines

The future looks big for small turbine engines—a very important field embracing the turbojet, turboprop and the shaft turbine engine for helicopters.

▶ **Developments Look Good**—In the past year, indications have been that there are several projects underway in the industry for small turbine engines of various configurations. As design and development work has proceeded, results have been very favorable.

None of these small engines has reached any substantial degree of operation. However, in about five years the small turbine engine should be a common production item. Most of these engines, of course, will have been developed and produced under military contract.

It can be expected that the small turbine engine, being somewhat in a period of refinement after a relatively long-established basic jet era, will emerge in designs radically different from the old breed. They probably will be easier to manufacture, but if maximum efficiency is aimed for, they still won't be in the "inexpensive" category.

Design of these engines will still be relatively intricate. It is expected that it will take the same kind of tremendous engineering facilities to do basic exploration and development as is required for big engines. This indicates that it might be a "big company" development task—although many in the industry would disagree with any such contention. As a matter of fact, some relatively small companies are firmly established in the small turbine field.

Companies already identified with the small turbine endeavor include General Electric, Westinghouse, Fairchild, Continental, and Lycoming.

▶ **Theoretical Advantage**—Small turbine engines have a theoretical advantage with respect to the thrust-to-weight ratio—providing the size of accessories can be controlled. This much better T/W opportunity in the small-turbine field may result, in the near future, in a configuration having a ratio of about 10.

Power range in the small-turbine field may extend from about 500 to 4,000 lb. thrust or horsepower as a general classification, although present efforts in this country may, in the main, be far from the top figure.

▶ **Small-Turbine Uses**—The small turbine engine is applicable to a variety of aircraft:

• Helicopters. The copter would provide an outstanding application for the small turbine engine—a shaft turbine

configuration for turning the rotor.

The turbine engine's characteristics—operation at constant speed and output—make the powerplant a top candidate, for example, for hovering, since the helicopter does not take any less power for this flight regime than it does for translational flight. In effect, the copter is a constant speed machine, with maximum and cruise powers about the same.

For some time to come, the copter probably will not have more than two engines, hence the turbine powerplant for the craft will be somewhere within the 1,000-4,000 hp range. (Sikorsky's S-56 has two piston engines of about 2,100 hp each.)

Special designs for the Navy or other uses may involve higher-power engines.

At this reading, it would seem that the Navy and Army are more interested in gas turbines for copter application than is the Air Force.

• **Trainers.** The use of small jets in trainers is bound to be a big field. Relatively new in this country, more emphasis is bound to be placed on the small jet trainer category. As time passes, airframe builders will be in the fortunate position of having a variety of small turbine engines to choose from for their particular design configurations.

• **Transports.** Applications of the small turbine engine in this field in the near future would be limited generally to small-to-medium turboprop-driven aircraft. This particular field is in a state of flux, and engine powers under consideration range anywhere from 1,500 hp up.

• **Ground-support planes.** This category may come in for a complete new evaluation with increasing small turbine availability. Previously, general unavailability of this type of engine, coupled with high specific fuel consumption, was considered a stumbling block in the development of the small ground support plane.

• **Missiles.** This may be a very substantial field for the small turbine engine. Here, the stress is likely to be on the "expendable" type—the engine will be designed for the job—rather than on use of "surplus" bigger jets.

• **Executive aircraft.** This type of plane offers another field for the small turbine engine, but it isn't likely to offer much of a market until long after transport applications have become established.

▶ **British-U. S. Status.**—In Britain, most of the work on the small turbine engine has been done by Rolls-Royce (R.B 109, Soar and Dart), Bristol (B.E 25) and Napier (Eland). In general, these companies have done more on the small turbine configuration—particularly the turboprop—than has been done in this country.

Britain has produced more small tur-

bine engines sooner than developers in this country, hence may logically be considered to be ahead of us in this field.

By 1960, small turbine development in U.S. should pull ahead of Britain's status, principally because of the large amount of money being poured into engineering facilities which will back up the small turbine effort.

General Electric Co. alone now has over $60 million invested in engineering facilities for jets. In the next few years it will have put into this type of property upwards of $100 million.

Pratt & Whitney's investment in general turbine engineering facilities will be about the same. Although it is not in the small turbine field now, engine industry observers feel that the company is sure to get into this development effort. When it does, P&W's huge investments in engineering facilities undoubtedly will pay off.

Britain has more trained manpower in the small-turbine field than we have applied to it in this country. Now, however, a vigorous recruiting program is underway here to bring engineering personnel into small-turbine development.

Ramjets

The ramjet is not the simple engine it was once thought to be. Today, engine men say it's a complicated unit. Consider, for example, its control and burner problems.

▶ **Needs a Shove**—Chief among the disadvantages of the ramjet is that it must first be brought up to speed before it becomes operational. In effect, this requires two powerplants. As much equipment (for instance, a booster) is involved in bringing the ramjet up to speed as is involved with the ramjet itself. When the weight of this equipment is added to the ramjet weight, the thrust/weight ratio is much less than expected.

Also, the speed limits of the turbojet have been increased sharply, so that the speed fields of applications for the ramjet—somewhere between the turbojet and the rocket—have been squeezed together considerably. In addition, the turbojet offers the advantage of starting from a standstill, which the ramjet cannot do.

▶ **Ramjet Jobs**—Some industry observers see the next round of powerplants for fighters and bombers as very-high-thrust turbojets. This, they say, will be followed by another round of engines which are likely to be ramjets or rockets. This status, it is said, may be reached within the next 10 years. Others feel that the ramjet generally will not be used in man-carrying aircraft.

Another possibility exists for ramjet use in missiles, particularly the air-

launched type, where no booster would be required. For a ground launched missile, the ramjet would have to have a booster to accelerate it from rest to its operational speed.

Ramjet status might be said to be "late development, soon production" in certain size categories for immediate future military applications.

Rockets

The rocket engine already has established a firm base for itself in the propulsion field. It has been restricted almost entirely to missile applications—already it is powering well over half of the missiles in this country.

▶**Bright Promise**—Considerable development work has gone into advanced types of rocket engines destined for really big missiles and aircraft. These have shown considerable promise in the last year or so, but much work still remains to be done to bring them to the perfection desired. These are considered a new breed of engines, about ready to go into production, with a real promise of service reliability.

This new round of rocket powerplants is considered far beyond the earlier experimental types, which nevertheless are highly developed.

At the moment, application of the rocket engine is not so strong for aircraft as it is for the missile. While it has the unique feature that thrust is almost completely independent of speed or altitude (in the upper reaches there would be nothing in its class), there is a drawback in the form of enormous fuel consumption.

Its application in aircraft will be decided by whether urgent military need justifies an airplane of limited versatility (relatively short endurance in comparison with an air-breathing engine).

There is a question whether large engine companies are the logical place for rocket engine development at this time, considering the degree of specialization required. Some think that companies which make their living from manufacturing large quantities of articles are not always too keen to develop new items requiring a high degree of specialization. There is feeling that the bulk of rocket engine development may logically end up in relatively small companies—at least initially.

Nuclear Power

The nuclear propulsion engine holds grand promise for the future of aeronautics, but trained observers feel that a tough development road lies ahead.

▶**Tough Tailoring**—Tailoring the engine to aircraft will be a colossal job, considerably more difficult than the submarine installation which has already materialized.

Unlike making a large piston engine,

the problem of making a large turbojet engine is no big difficulty. But teaming this large turbojet with a reactor for heat generation is the big task.

Considering the weight a nuclear propulsion engine would be expected to have in its initial stages of development, it is logical to believe that its applications would have to be limited to a subsonic plane. It would seem that the weight penalty envisioned now would be impossible to overcome in the very close future.

Much effort is being directed to overcome the drawback of heavy shielding.

Titanium

A few years ago, the general feeling in the engine field was that new metals would have to be developed to keep pace with jet engine progress. However, with relatively the same metals, the jet engine has become a still greater success.

▶Pro & Con—Now, because strength-weight and temperature-resistance improvements are indicated by titanium and its alloys, this metal is being actively applied and considered in the engine field. But perhaps the enthusiasm is a bit thinner than the feeling when the metal first came into the picture a few years ago.

In some quarters, it is said that titanium is not an essential metal for a highly successful turbine engine. Emphasis, it is felt, should be on airframes rather than on engines, although it is recognized that the metal should be pushed for use in engines as well, because of the characteristics and benefits it offers.

Opinion in favor of the metal is more positive. Titanium's supporters say that problems encountered with it are no more insurmountable than those which were encountered with aluminum and its alloys in early years of use, and that the sooner titanium is readied for large-scale applications in jets, the sooner certain target goals can be attained.

Titanium and its alloys could be used anywhere in the engine, except in the hot parts. It could be used advantageously at the rear end of the compressor, where temperatures are going up, particularly in new compressor designs. It also could be used in compressor disks, blades, and various housings.

Complaints voiced against the metal are that material is not uniform, characteristics deteriorate with age when it lacks high purity, high cost of the material and of processing.

These disadvantages would seem to be routine with the introduction of any new metal. Within a relatively short time, they probably will be over-

● ENGINEERING

come and the use of the metal extended far beyond its use today in engines

Problems

There's a host of big problems facing the engine researcher, designer and manufacturer. The coming years, which seem to promise great progress, will need greater teamwork among these three activities than ever before.

Some of the pressing problems facing these three segments in varying degrees include the thrust weight airflow temperature relationship, the need for greater engine efficiency and reliability, the pinch of strategic materials, and operating conditions associated with highspeed flight.

The turbojet probably is subjected to more of these problems than other types of engines, considering its more advanced development status and wide use. But the same factors affect the other engine types in varying degrees.

For power potential, the aim is to obtain as much thrust as possible for as little engine weight as possible. Thrust is determined by the quantity of air going through the engine and the temperature at which the air is burned. Weight of the engine is determined by the amount of metal put into it.

Hence, the designer is trying to put more air through the engine and burning it at higher temperatures, while the manufacturer is trying to take metal out of the engine. One method of obtaining more airflow is by decreasing the hub diameter of the compressor, another approach is to increase the air velocity through compressor design, as is done in the progression from the subsonic to the transonic compressor.

Temperature actually determines how much thrust is obtained for each pound of air burned. In the early days of the jet, temperature was limited to about 1,200F ahead of the turbine. Now, temperatures in that region are up to 1,500-1,600F. At this temperature, only about one-quarter of the air is burned. If all the air would burn, temperature would reach about 3,500F.

Thus, considerably more thrust is available, but the problem is to extract this power without burning up the turbine.

The method now used in the solution of this difficulty is to use the afterburner to burn almost all of the remaining three-quarters of the air passing through the engine. Better solutions await development.

Taking metal out of the engine is a complicated consideration because of the many operational characteristics actually dependent on material strength and shape. Lightening the engine is a problem which will have to be solved progressively, and gains are not likely to be made in big jumps. New, light-

weight, strong metals offer one path of solution but usually bring with them new headaches for the manufacturer.

▶**More Efficiency Needed**—Increased engine efficiency is a top goal—getting more miles per pound of fuel. The job is not easy. Much of the difficulty is related to temperature.

The general objective is achieved by increasing the efficiency of each of the components, from one end of the engine to the other. The combustion chamber is a good example. Here we want to burn all the air possible because any not burned means a loss in efficiency.

Although the afterburner helps, losses are involved here too. Actually, it is more efficient to burn a greater proportion of air in the main combustor. This, however, means turbine cooling is needed to counteract the temperature rise on this component. Cooling introduces design complications, operating problems and fabrication difficulties.

▶**Reliability Affected**—The overall approach to increased thrust, increased airflow, decreased weight, and increased efficiency has a direct bearing on engine reliability.

For example, decreasing the hub diameter to obtain more airflow means that the compressor blade will be longer and the effect of centrifugal force will be greater. This means the blade will have to be made stronger.

When operating at higher temperatures, the metal component subjected to the rise gets weaker.

Taking metal out of the engine obviously affects reliability with regard to rigidity and strength.

▶**Inlet, Exhaust Difficulties**—New problems likely to be encountered in speeds of the near future have to do with inlet and exhaust conditions. Above M 1.5, the problems of designing an adequate inlet diffuser and exhaust nozzle to take care of supersonic flow becomes critical.

Solution of these conditions is necessary, or the air going through the engine is cut down, drag of the engine opening is increased, and efficiency of the engine drops. This will require a device to vary the area and contour of the inlet diffuser and the exhaust nozzle to achieve adequate compression due to ram at various flight speeds. At the same time, the device must meet the quantity flow requirement of the compressor.

If proper variation in the diffuser area and contour is not obtained when the speed is raised, spillover and choking will result.

If proper conditions at the exhaust nozzle are not obtained, efficiency is lost and flow conditions throughout the entire engine are upset by the creation of a back pressure effect.

▶**Ram Heat**—Ram temperature is another vital factor to be reckoned with. The problem generally is expected to occur at about M 2 and to become appreciably worse with higher speeds.

Translated directly, ram temperature increase means boost in inlet temperature. This leads to the need for burning less fuel so that proper turbine temperature will not be exceeded. Burning less fuel, in turn, means less thrust per pound of air.

Solution to this difficulty would seem to be the burning of more fuel in an afterburner to achieve the thrust desired, resulting, in turn, in less engine efficiency.

Here again, it would seem that increased ram inlet temperature will have to be overcome through turbine cooling.

Cooling probably will involve taking air from the compressor outlet and directing it back through the hollow turbine buckets. The higher flight speeds will give higher ram temperature, higher compressor outlet temperature, hence higher temperature air for cooling the turbine blades, indicating that as speeds climb the difficulty is aggravated.

In the operation of future jets, bearings also loom as a big problem. Synthetic lubricants will help, as will better bearing material, but the future situation is much too perplexing for complacency at the present reading.

Transition Marks Structural Design

Aircraft structural design is showing signs of transition from the traditional approaches to broad new avenues which lead toward solutions of the myriad problems of the supersonic era.

Metallurgy, machine tools and mammoth computers are in the catalog of new tools with which structural designers are forging the aircraft of tomorrow. With the aid of new metals, specialized production methods and a host of analytical techniques, engineers can tackle the specialized studies of wings and tails and fuselages to a detail not possible before.

This is the brightest highlight in the picture, the areas in shadow show that there is much data still to come, many more tests to be made, and a tough hurdle—thermal effects—to leap.

▶**Many Methods**—There are probably as many different kinds of basic structural approaches as there are designers. There is, for example, a division in the aircraft industry on designing into the heavy press program, some will and some won't.

There are strong proponents of titanium to replace structure now made from steel or high-strength aluminum.

Some designers will use metal bonding on primary structure; others wouldn't touch it with a 10-ft wing spar.

The significant point of all this is that for the first time in aircraft design, there is such an amazing divergence of beliefs and opinions in structural layout.

▶**Historically**—There was something like this back in the days when aircraft were making the change from wood, steel tube and fabric to all metal shell construction. Spread out over a period from the first World War until the second, that transition was a slow one and generated only one argument: All-metal or not all-metal makeup.

Structure evolved after the all-metal principles were accepted almost universally. Until short months ago, every airplane in this country and abroad was built in the traditional manner, starting with sheet metal or bar stock, then shearing, routing in the flat, forming, and assembling. These tiny assemblies were then fastened together into bigger ones, and those into major components of the final airplane. As a last step, large sections of the plane—wings, tail, fuselage—were fed into assembly lines and stuck together into a single aircraft.

"This is a medieval way to build airplanes," said the president of one of the biggest fighter factories. Most production men and engineers would agree in principle with him.

▶**Threshold**—Production experts had long been frustrated by the bits-and-pieces makeup of airplanes. It wasn't like the automobile industry, where half-a-dozen large stampings made a complete body shell. It was more like building watches, where each tiny part had to be built to a close tolerance, and then assembled into a complete unit also to close tolerances.

Nevertheless, the United States entered into the supersonic age still building its airplanes—with one or two notable and pioneering exceptions—in the same medieval manner.

Flight at increasing speeds brought with it a host of problems for aerodynamicists, powerplant and structures people. Aeronautical progress was like a three-legged stool, with a leg for each group of engineers. If one leg was weak, the whole stool would topple.

One after the other, advances piled on advances. The increasing store of knowledge brought impressive improvements in aerodynamic layout and powerplant outputs. Structural ideas lagged the pack.

▶**Speed Is the Key**—Supersonic flight generates all its problems simply because of the effects of speed. To go fast, the airplane must have low drag; small, thin surfaces must be used.

But thin wings are poor structurally, deflections under loads are high; torsional and bending loads that could normally be handled by a thick straight wing now have to be carried through a swept, thin surface.

Fast airplanes require lots of energy to maneuver them; thus, control forces must be high. To apply a large force at the edge of a thin and swept wing or tail introduces a complex of load paths and deflections undreamed of a decade ago.

As speeds increase, loads increase with the square of the velocity. High-altitude operation has helped somewhat, but airplanes still have to fly and fight at low altitudes. The airplane doesn't exist that can't be broken up by flying low enough and fast enough.

▶**Faster and Hotter**—Speeds increase further, and the airplane runs into a phenomenon of the jet age—the thermal effects of skin friction. This is not, in any sense of the word, a barrier to aircraft designers. The sonic barrier could be defeated by power or aerodynamic design and once hurdled, was relatively impotent to cause any further trouble.

But thermal effects increase with

speed, they cannot be avoided or circumnavigated. They have to be countered by design.

So a whole new set of design parameters have grown out of the peculiar requirements of thermal effects. This has been brought home to missile designers, who have been faced for some time with the necessity of holding structures together at red heat. Their only advantage has been that a missile can have a short life, its inherent heat capacity allows it to absorb heat and glow for a few seconds before the structure is weakened. But by that time the missile has impacted the target, and its strength is only a matter of academic interest.

This is the background to an understanding of the problem.

▶ **The Problem**—A structures man now looks at airplane configurations which call for operation from zero speed to Mach 3 or better at any altitude from sea level to 100,000 ft. The control systems of the aircraft may force it to maneuver at loads up to 16 or 20G, if the vehicle is unmanned, and considerably less if a pilot flies it.

Skin temperatures may approach 1,000 F or better in special locations. There may be a tremendous amount of heat generated inside the fuselage—from avionic gear or other equipment—which has to be dumped somewhere.

The air loads will be large for normal operations, for maneuvering at supersonic speeds, they may be monstrous. To drive the final nail, the aerodynamicists have chosen 5% thickness ratios as the absolute upper limit for the wings and tail surfaces.

▶ **First Aid**—A few years ago, a list of requirements such as this one would stymie the best engineers. But now, they are much better equipped to handle the situation.

First of all, load computation, once a tedious manual operation, can now in large measure be transferred to computers. Using punch-card or taped data fed in from windtunnel tests, these computers will grind out load distributions for an enormous number of combinations of flight speeds and load factors.

The data the computer has to draw on is better and more complete. Much of it can now come from flight test data on the instrumented airplanes, flown for the specific purpose of getting pressure distributions and air loads. Other data is drawn from pressure-distribution tunnel tests.

▶ **Breakdown**—Understanding the load distribution is the first and greatest commandment of the structural engineer. If he understands the problem, he has it half solved.

The detail design of components from here on is his own problem. But

it has been eased by new manufacturing methods.

Major portions of complete wing panels can be machined from a single slab of metal, complete with internal integral stiffeners. For jobs that the milling machine can't do, chemical milling offers an alternative. With this new technique, milling is not limited by shape, direction of cut or radius of cutters. Both sides of a sheet may be milled at the same time. Another alternative is to bang these formed sheets out on a heavy press, achieving an enviable production rate.

▶ **Materials**—Where once there was only aluminum, now there is aluminum, titanium and steels. Titanium has strong proponents in the industry, who tout it as the replacement for other metals up to moderate temperatures. Current applications include hot spots around engine installations, in jet tail pipe shrouds and some structure.

Glass plastics and other plastic materials have come into their own since avionic equipment and antennas went underground. Flush antennas require a window that electrons can look through, and plastics give the answer. Improvement in their composition has produced plastics that will withstand the high temperatures reached today. In radomes and tiptanks and flush panels, plastics have carved a huge niche among aircraft materials.

▶ **Fabrication**—Rivets, the traditional method of sticking parts of an airplane together, still are used by the billions. There has been some replacement of riveted construction by metal bonding, particularly with secondary structure. Primary structure is being "glued" together in limited cases.

As loads change and increase, rivets have been supplanted by bolts. Thousands of steel bolts add considerably to the weight of the airplane, titanium bolts and nuts are available, and are being designed into new aircraft.

These are only a few of the highlights in structural methods and techniques. There have been advanced new concepts of design, suggesting, for example, that airframes be designed to a specified life. Creep, the slow deformation of a structure under load, is being attacked on that basis.

There are still new materials on the horizon. The NACA research airplane program, coupled with the flight test programs of manufacturers, is yielding new flight data on loads. More and more tunnel tests are adding to the backlog of information.

But most vital to progress is continued thinking in new directions. New concepts of design, different manufacturing tricks will come from this to be added to the ever increasing backlog of information at hand.

Human Factors Problem . . .

Airplanes Change But Man Doesn't

The ever growing realization that man and modern aircraft are not basically compatible has resulted in the growing importance of the human factor in aviation.

The problems indigenous to the integration of the man with the airplane have been recognized by the military and manufacturers for some time. Unfortunately, the tendency was to recognize the problem and let it go at that.

But a few small groups who could see into the future hammered away at the fact that the jet age would pose some knotty problems concerning the men who would fly the new super aircraft.

To appreciate the extent of this problem, it is only necessary to take an objective look at man and the modern airplane.

▶**Fixed Design**—Man is an absolute fixed design condition. He cannot be altered dimensionally, biologically or chemically. None of the conditions necessary to sustain his life cycle functions can be compromised to any great extent. The greatest known calculators are incapable of analyzing him, and his functional system cannot be fooled by gimmicks or gadgets.

Studying man and designing for him involves quite an area of scientific, technical and professional activity. The fields of medicine, psychology, physiology, anthropology, physics, dynamics, biochemistry, botany and optics—to mention a few—are involved. Cataloging the knowledge of these areas in usable form that can be applied to aviation problems is a challenge in semantics by itself. Although they all contribute to the study of man, each scientist and technician has his own specialized technical language, which must be translated into terms the design engineer can understand.

▶**Changing Configuration**—From a design standpoint, the modern airplane is the antithesis of man. It is constantly changing. Its characteristics can be searched and analyzed minutely by the great calculating machines.

The technicians who design it are constantly dreaming up new gadgets, gimmicks, twists, angles, techniques and concepts to either guide it or fool it into flying higher, faster and further than ever before.

▶**Basic Incompatibility**—Both man and the airplane share a common element that is a friend to one and a deadly enemy of the other: dense, sealevel air. This fact is probably one of the most basic causes of incompatibility between man and the airplane that he flies.

Air density is a prime function of drag, and drag is the enemy of the airplane. To escape the penalties of drag, designers have to do two basic things, neither of which are compatible to man:

• They constantly try to shrink the physical size of the airplane. The advent of the razor thin wing and empennage has resulted in packing the fuselage tighter than a sardine can with equipment. Density becomes synonymous with performance. Space in an airplane becomes a precious commodity.

• They must get the airplane to operate at higher altitudes, where the air is thinner and the drag penalty less.

Obviously man does not fit into this picture. He does not lend himself to tightly packed fuselages, because he is dimensionally fixed and there is no way of compromising to any great degree the space he occupies. He does not like high altitudes because the rarefied air, and the extremes in temperatures are dangerous to his life cycle functions.

Therefore, it is absolutely essential for the airplane to carry equipment to support man's life cycle.

Thus in order to sustain a man, the airplane has to do two things: it is constantly fighting to eliminate space and weight.

▶**Design Compromises**—A design conflict of this nature always results in compromises. Unfortunately, with the accent on performance, the tendency has been to compromise the man who is to fly the airplane.

Because space is a precious commodity, the man is crowded physically as much as possible. The hundreds of items—such as instruments, switches, knobs, dials, valves and levers that he must use—are jammed into every conceivable nook and cranny of his already minimum sized cockpit space. Aerodynamics sets the location of his cockpit and the size of the canopy, oft times limiting his visibility.

Introduction of new systems and techniques adds to his training headaches.

The resulting maze of this complex electronic, hydraulic, electrical and mechanical gear work his mental, manual and sensory capabilities to their utmost extent.

This is the result of the design source knowing a great deal about the airplane and very little about the man.

▶**Basic Remedies**—The situation could possibly be remedied to some extent if

designers followed these basic procedures

• **Start with man** at the basic design stage of an airplane. The cockpit itself should be largely controlled by the dimensions and requirements of the man. Beyond this is the broader possibility that the shape of the forward section of the airplane may be largely influenced by man's visual and physiological data requirements—when these are integrated with the aerodynamic and structural configuration

• **Intensify the study of man** to correct the unbalance of knowledge. In this area, the production of accurate numerical data should be stressed. This will reduce the amount of personal opinion now being used in the place of objective design information.

• **Integrate the scientists** who study man into the overall airplane design effort. This can be accomplished if manufacturers maintain close liaison with elements devoted to human factors in the Air Force, Navy and private industry

• **Train development engineers** who will be able to handle the problem of human factors at the design stage in the future

This new type of engineer will have to be familiar with sciences beyond his usual world of aerodynamic, structural, mechanical and mathematical subjects. He will have to discern and appreciate the implications of the many sciences involved with the study of man. He will be required to be technically multilingual in order to work closely with these various sciences and professions.

Safety must be his byword. He will have to temper his enthusiasm with sound judgment. The great tool of trial and error will be lost to him. You do not mine, machine, roll or press the material he will be working with. Replacement parts take some 20 years or so to come by

▶ **Human Factors Internship**—The development of such an individual requires the creation of an integrated career and educational program. A technician of this type would need a period of internship that would enable him to acquire sufficient practical experience to integrate with his knowledge of the overall sciences. His university curriculum would involve possibly two to three years of additional study, after taking his bachelor's degree.

In order to draw recruits to this area of activity, sufficient interest will have to be stimulated in government and manufacturing areas to financially compensate individuals for the time and effort they will have to expend in acquiring their specialized education.

To further support this effort, it will

become necessary to convince qualified universities that such a curriculum is economically and scholastically feasible to develop. At the present time some universities are developing courses in Human Engineering. This is only a start and constant pressure must be exerted to guarantee an expansion of this area of activity.

▶ **Push-Button Rebuttal**—There are some who contend that to worry about the human factor at this stage of the game is a waste of time and effort, because the day of the push button airplane is almost here.

Those who beat the drums for push button aircraft tend to overlook a few things.

It is true that you can eliminate the man from a military aircraft committed to a one-way mission that results in the total destruction of both the aircraft and its target. But push-button warfare will involve the human factor at the launching sites and control rooms. Man's ability to monitor and operate the equipment necessary to launch and guide pilotless aircraft will have a large bearing on the success of these robot missions.

▶ **Unlimited Potential**—The importance of the human factor is not by any means constrained to the military effort. The fact that the airplane will continue to be man's fastest transportation medium

provides a field with unlimited potential for absorbing research and new engineering techniques

The study of the man in the military effort is aided to some extent because the personnel involved are to a great extent a selected group both from a physical, mental and psychological standpoint Their operational procedures and methods are monitored by a military discipline

The commercial field, on the other hand, enjoys none of these advantages Airlines carry passengers of all ages They cannot select their customers, and their discipline is at best an unknown highly unstable and exceedingly variable human factor

The safety and well being of the passengers flown by a commercial airline is entirely a function of the efficiency and reliability of the equipment it operates and the crew it trains In both areas, the human factor plays a major part

▶ **Large Job**—Promoting design consideration for man in an area of technical and military activity involving the airplane is no small order

The major burden of this effort is being shouldered by existing elements within the extructure of the Air Force, the Navy and some manufacturers Their numbers are few, considering the size of the job They have little or no voice in the formulation of the air weapon, they can make recommendations but not act

The process of educating the industry and the military in the value and importance of the human factor is complicated by the very nature of the subject

Some of the best scientific opinions advanced are subject to controversial argument by amateurs, dilettantes and the self styled expert Everyone professes a profound knowledge of what is best for the man

▶ **Reversed Concept**—Considering the man first in the process of designing equipment that he will operate, is literally a complete reversal of the accepted practice

In many cases, tangible measures of effectiveness are demanded before design concessions will be made This is sometimes a difficult requirement to meet when dealing with man's complicated mental processes

Specifications conflict, and changing or revising them to incorporate the human factor on occasions involves a process akin to amending the constitution.

Despite all of these headaches, the human factors groups have been making progress by the dint of sheer salesmanship, tireless effort and a vast amount of enthusiasm and devotion to a difficult and sometimes thankless task

Aircraft Industry—1954

Company	Location	Plant Area (sq ft.)	Employment	Sales	Net Income	Backlog Jan. 1 1955	Dividends Paid to Stockholders	Product
Aero Design & Engineering Co.	Bethany, Okla.	311 800	477	$3 644 131	—	$1 151 500	—	Twin-engine aircraft
Aeronca Mfg. Co.	Middletown, Ohio	600 000	3 054	16 000 000	$600 000	30 000 000	—	Airframe components
Allison Div., General Motors Corp.	Indianapolis, Ind. Dayton, Ohio	4 324 344 655 055	13 [illegible] 3 [illegible]	Financial data reported by General Motors Corp.				Aircraft engines, propellers
Beech Aircraft Corp.	Wichita, Kan.	1 694 433	8,933	78 033 435	3 360 030	90,000,000+	$1.25 per share	Aircraft
Bell Aircraft Corp.	Niagara Falls, N.Y. Ft. Worth, Tex.	2 161 [illegible] 843 135	14 236 3 355	158 344 131*	4 395 542*	373 000 174	2 for 1 stock split	Missiles, rocket motors, helicopters, avionics
Bellanca Aircraft Corp.	New Castle, Del.	190 000	130	1 354 646	—37 471	1 027 000		Airframe components
Bendix Aviation Corp. (includes 20 mfg. divisions)	S. Bend, Ind.	5 000 000	48,341	607 711 037	25,537 711	427 000 000	$4.00 per share + 2-for-1 stock split	Avionics, aircraft equip., missiles
Boeing Airplane Co.	Seattle, Wash. Wichita, Kan.	8 214 209 4 000 332	31,251 18 000	771,311 228*	27,139,384*		2-for-1 stock split + $3.00 per share	Aircraft
Callair	Afton, Wyo.	22 800	16	50 578		16 000	—	Aircraft
Cessna Aircraft Co.	Wichita, Kan. Prospect, Kan. Hutchinson, Kan.	908 040 184 010 128 200	2 247 1 [illegible] 225	40 114 000	5 105 000	40 000 000	$548 000	Aircraft and hydraulics
Champion Aircraft Corp.	St. Paul, Minn.	(Recently purchased design rights, tools, dies, etc., for Aeronca Champion aircraft)						
Chance Vought Aircraft, Inc.	Dallas, Tex.	2 234 748	13 672	131 071 509*	5 164 737*	248 000 000*	$.80 per share*	Aircraft and missiles
Convair (Division of General Dynamics Corp.)	San Diego, Calif. Ft. Worth, Tex. Pomona, Calif. Daingerfield, Tex.	4 361 000 4 344 500 1 331 000 120 000	21 870 17 232 5 [illegible] 284	Financial data reported by General Dynamics Corp.			100% stock dividend in 1955	Aircraft and missiles
Curtiss-Wright Corp.	Wood Ridge, N.J.	[illegible]	25 107	475 064 415	18,377,279	730,000 000	—	Engines, propellers, electronics
Douglas Aircraft Co., Inc.	Santa Monica, Calif. El Segundo, Calif. Long Beach, Calif. Tulsa, Okla.	3 303 000 4,131 000 3,1[illegible] 000 2 552 000	17 857 25 443 21 211 10 [illegible]	818,218 705	38 158 801	2,555,000,000	$6.50 per share + 2-for-1 stock split, additional 2-for-2 split in 1955	Aircraft and missiles
Fairchild Engine & Airplane Corp. Engine Div Missiles Div Stratos Div Speed Control Div American Helicopter Div	Hagerstown, Md. Farmingdale, N.Y.	1 537 148 835 000 175 000 144 000 17 000 8[illegible] 000	14 515 (total all divisions)	108,450 000*	5 185 000*	—	$2,138,941	Aircraft, missiles, electronics, helicopters, engines
Fletcher Aviation Corp.	Rosemead, Calif.	120 000	600	18 000 000	150 000	4 537 000	$51 [illegible]	Fuel tanks and aircraft
General Electric Co. Gas Turbine Div	Evendale, Ohio	4 700 000	18 000	Financial data reported in corporate statement				Engines
Glenview Metal Products Co.	Riverside, N.J.	18 000	163	—		—	—	Aircraft and engine parts and helicopters
Goodyear Aircraft Corp.	Akron, Ohio	4 043 256	13 000					Blimps
Grumman Aircraft Engineering Corp.	Bethpage, N.Y. Peconic River, N.Y.	3 815 584 535 [illegible]	11 005 554	235 878 127	11,214 553	593 000,000**	$5 000,000	Aircraft
Hiller Helicopters	Palo Alto, Calif.	150 000	810	6 381 128	—97 709	12 224 [illegible]	$187 000	Helicopters
Hughes Aircraft Co.	Culver City, Calif.	2 000 000	17 500					Avionics and missiles
Jacobs Aircraft Engine Co.	Pottstown, Pa.	178 000	530	4 500 000		4,000 000	—	Engines and parts
Kaman Aircraft Corp.	Bloomfield, Conn.	242 000	1 200					Helicopters
Kellett Aircraft Corp.	Camden, N.J.	—				—	—	Helicopters and research
Lamson Aircraft Co., Inc.	Seattle, Wash.	20 000	42	Just beginning production				Aircraft
Lockheed Aircraft Corp. Missile Systems Div Georgia Div Subsidiaries	Burbank, Calif. Van Nuys, Calif. Marietta, Ga. Burbank and N.Y.C.	6 257 400 353 700 4 270 300 1 326 500	25 071 1 245 14 378 4 179	750 000 000**	17,143 500*	1 000,000,000+**	$6 [illegible] 294 10% stock dividend	Aircraft, missiles, maintenance
Glenn L. Martin Co.	Middle River, Md.	3,099,330	16,030	187 178,447*	14 560 687*	—	$1.50 per share +10% stock dividend	Aircraft and missiles
McDonnell Aircraft Corp.	St. Louis, Mo.	3 585 843	13 318	123 091 [illegible]	3 421 417	441 371 [illegible]	$694 290	Aircraft, missiles, helicopters
Mooney Aircraft, Inc.	Kerrville, Tex.	34 200	47					Aircraft and parts
North American Aviation, Inc.	Los Angeles, Calif. Columbus, Ohio Downey, Calif. Fresno, Calif.	4 007 000 3 246 100 1 535 000 340 000	25 000 15 248 11 665 2 235	643 321,018	22 178,726	1 174 000,000	$2.75 per share	Aircraft, missiles, rockets, avionics, nuclear power
Northrop Aircraft, Inc. Anaheim Div Radioplane Co.	Hawthorne, Calif. Anaheim, Calif.	2 815 278 288 644 200 000	20 013 1 358 1 155	171,000,343	3,820 367	542 000,000	$672 378 +10% in stock, also 3 for-1 stock split	Aircraft and missiles, opto-mechanical equipment
Piasecki Helicopter Corp.	Morton, Pa.	[illegible] 000	3,536			100,000,000*	10% in stock	Helicopters
Piper Aircraft Corp.	Lock Haven, Pa.	312 000	1,208	11 424 181	367 618	6 354 436	$85 705	Aircraft
Republic Aviation Corp.	Farmingdale, N.Y. Port Washington, N.Y. Greenlawn, N.Y. Hicksville, N.Y. New York, N.Y.	1 862 550 226 617 45 527 31 500 230 155	18 205 3 237 473 50	654 000 000		1,000,000 000	$2.00 per share +10% stock dividend	Aircraft
Rotor Craft Corp.	Glendale, Calif.	3 800	18					Helicopters
Ryan Aeronautical Co.	San Diego, Calif.	750 000	3 750	48 000 000	1 440 000	42 000 000	$400 000	Aircraft and missiles engine parts, avionics
Temco Aircraft Corp.	Dallas, Tex. Garland, Tex. Greenville, Tex.	1 310 101 232 748 292 204	6 000 600 1 000	58 209,420	2,037,283		1,287 000	Aircraft components, modification, overhaul
United Aircraft Corp. Pratt & Whitney Aircraft Div Hamilton Standard Div Sikorsky Aircraft Div	E. Hartford, Conn. E. Hartford, Conn. Windsor Locks, Conn. Bridgeport, Conn.	 6 000 000 1 000 000 900 000	2 000 34 000 7 000 5 000	650 000 000**	25 000 000**	1 225 000,000*	$3.50 per share	Engines, propellers, accessories, helicopters
Westinghouse Electric Corp. Air Arm Div Aircraft Gas Turbine Div	Baltimore, Md. Kansas City, Mo. S. Philadelphia, Pa.	312 000 3 300 300 301 000	2 800 4 025 1 250	Financial data reported in corporate statement				Avionics, engines

*9-month figures. ** Estimated. Source: Industry reports to AVIATION WEEK.

U. S. Military Aircraft

BASIC AIRCRAFT DATA					DIMENSIONS				WEIGHTS			POWERPLANT
Manufacturer	Military designation	Military name	Primary mission	Number in crew	Overall span ft.	Overall length ft	Overall height, 3-pt. ft.	Gross wing area, sq ft	Weight empty lb	Normal gross wt., lb	Maximum gross wt., lb	Number, manufacturer, model and max. rating
Beech Aircraft Corp Wichita, Kan.	L-23B		Lt. trans.	6	45' 3"	31' 6"	11' 4"	277		6 000		2 Lyc GO-435-C2 @ 260 hp
	T-34A	Mentor	Trainer	2	32' 10"	25' 11"	[illegible]	178	2 170	2 900		1 Con. O-470-13 @ 225 hp.
Boeing Airplane Co. Seattle, Wash.	B-47E	Stratojet	Med. bomb.	3	116'	107'	28'				200 000	4 GE J47-GE- @ 6,000 lb.t.
	B-52	Stratofortress	Heavy bomb.	6	185'	156'	48'				350 000	8 P&W J57 @ 10 000 lb t
	KC-97G	Stratofreighter	Tanker-trans.	5	141' 3"	110' 4"	38' 3"	1 768	78 884	150 000	175 000	4 P&W R-4360-59B @ 3,500
	KC-135	Stratotanker	Tanker trans.									
Cessna Aircraft Co Wichita, Kan.	XT-37		Trainer	2	33' 0"	29' 1"	9' 10"			5 000		2 Con J69 @ 900 lb t.
	OE-2			2								1 Con @ 265 hp
Chance Vought Aircraft, Inc. Dallas, Tex	F7U-3	Cutlass	Fighter	1	38' 8"	44' 3"	14' [illegible]		18 210	27 340	31 642	2 West J46-WE-8 @ 6,000
	F8U-1		Fighter	1								1 P&W J57
Convair Division, GDC San Diego, Calif	B-36J		Heavy bomb.	15	230'	162' 1"	46' 9"	4 772			100 000+	6 P&W R4360-53 @ 3,500 hp
	B-58	Hustler	Bomber									GE J79
	F-102A		A-W inter	1	38' 2"	68' 3"	18' 2"					1 P&W J57 P 11 @ 10,000 lb.t.
	T-29C	Flying Classroom	Trainer	4	91' 9"	74' 8"	27' 1"	817	29 000	43 575	43 575	2 P&W R2800-50W @ 2,500
	C-131A	Samaritan	Air evac.	3	91' 9"	74' 8"	27' 3"	817	29 000	43 575	43 575	2 P&W R2800-99W @ 2 500
	C-131B		Test bed		105' 4"	79' 2"	28' 2"	920	29 248	47 000	47 000	2 P&W R2800-[illegible]W @ 2 500
	YC-131C		Exp trans.	3	105' 4"	79' 2"	28' 7"	920			47 000	2 All YT56-A3 @ 3 250 hp
	C-131D		Transport	3	105' 4"	79' 2"	28' 2"	921	29 000		47 500	2 P&W R2800-CB16 @ 2,[illegible]
	XFY-1	Pogo	Fighter	1	25' 8"	34' 10"	23' 11"					1 All. T40 @ 5,850 hp.
	XF2Y-1	Sea Dart	Fighter	1								2 West J46 @ 6 000 lb.t.
	R3Y-2	Tradewind	Transport	5	145' 9"	139' 8"	51' 6"				165 000	4 All. T40-A-10 @ 5,500 hp
Douglas Aircraft Co., Inc. Santa Monica, Calif	B-66B		Tac bomber	3	72' 6"	75' 2"	23' 7"	780	40 305	78 000	83 000	2 All. J71-A-9 @ 9750 lb t.
	RB-66B		Night PR	3	72' 6"	75' 2"	23' 7"	780	38 685	[illegible]0 000	[illegible] 000	2 All J71 A-9 @ 9,750 lb t.
	C-124C	Globemaster 2	Cargo trans.	5-8	174' 1"	130' 0"	48' 3"	2 506	101 165	185 000	225 000	4 P&W R4360-63A @ 3 800
	AD-5	Skyraider	Attack	1-3	50'	40'	15' 8"	400				1 Wr R3350 @ 2 700 hp
	A3D	Skywarrior	Attack	3	72' 6"	74' 5"	22' 9"					2 P&W J57
	A4D	Skyhawk	Attack	1	27' 6"	39' 1"	15' 2"					1 Wr J65 W-4
	F4D	Skyray	Interceptor	1	33' 6"	45' 8"	13' 0"	557				1 P&W J57
Fairchild Aircraft Div Hagerstown, Md	C-119G	Flying Boxcar	Cargo trans.	5	109' 3"	86' 6"	26' 3"	1 447	39 820	64 000	77 000	2 Wr R3350-35W @ 3,500
	C-123B		Cargo trans.	2	110'	76' 1"	34' 1"	1 223	31 085	54 000	60 000	2 P&W R2800-99W @ 2 500
Grumman Aircraft Eng g. Corp. Bethpage, L. I., N. Y.	F9F-8	Cougar	Fighter	1	34' 6"	41' 7"	12' 3"					1 P&W J48-P 8 @ 7,200 lb.t.
	F9F-9	Tiger	Fighter	1	31' 8"	46' 10"	12' 2"					1 Wr J65-W-6
	S2F		Anti-sub	4	69' 8"	42' 3"	16' 3"					2 Wr R1820-82 @ 1 525 hp
	SA-16A	Albatross	Rescue	6	80'	62' 4"	24' 5"		24 000		34 000	2 Wr R1820-76A @ 1 425 hp
Lockheed Aircraft Corp Burbank, Calif	F-104		Fighter	1	22'					16,000		1 Wr J65-W-6
	T-33A		Trainer	2	38' 11"	37' 8"	11' 8"	238	8 400		15 000	1 All J33 A-35 @ 5 200 lb.t
	C-121C	Super Constellation	Transport	6	123' 6"	116' 2"	24' 9"	1,651				4 Wr R3350 @ 3 250 hp
	RC-121D		Early warning	32								4 Wr R3350 @ 3 250 hp
	C-130A	Hercules	Transport	4	132'	95'	38'					4 All T56 @ 3 750 hp
	T2V-1		Trainer	2								
	XFV-1		Fighter	1								1 All T40 @ 5,850 hp
	P2V-7	Neptune	Anti-sub.		103'	91' 8"	29' 4"	1 000	43 330	75 500		2 Wr R3350-32W @ 3,500 2 We J34 @ 3 400 lb.t.
	R7V-2	Super Constellation	Transport	4-15	117'	116' 2"	24' 8"				150 000	4 P&W T34 @ 5,500 hp
	WV-2		Radar search	31	123' 5"	116' 2"	24' 8"	1 654				4 Wr R3350-34 @ 3 250 hp
Glenn L. Martin Co Baltimore 3, Md.	B-57B		Tac bomber	2	64'	65' 6"	15' 7"				53 000	2 Wr J65-W-5 @ 7,200 lb.t
	P5M-2	Marlin	Anti-sub.	7	118' 2"	68' 11"	33'	1 406	46 093		73 055	2 Wr R3350-32W @ 3 400
	XP6M-1	Sea Master	Mine-laying	5								4 All J71 @ 10 000 lb.t
McDonnell Aircraft Corp. St. Louis, Mo.	F-101A	Voodoo	Fighter	1	39' 8"	[illegible] 5'	18' 0"				32 500	2 P&W J57 P 13 @ 15,000
	F3H-1N	Demon	Fighter	1	35' 4"	59'	14' 4"					1 All J71
North American Aviation, Inc. Los Angeles, Calif	F-86D	Sabre	Fighter	1	37' 1"	41' 9"	15'				18 000	1 GE J47-GE-17 @ 5 200 lb
	F-86F	Sabre	Fighter	1	37' 1"	37' 6"	14' 7"				17 000	1 GE J47-GE-27 @ 6,000 lb
	F-86H	Sabre	Fighter-bomb.	1	37' 1"	38' 8"	15'					1 GE J73-GE-3
	F-86K	Sabre	Fighter	1	37' 1"	43' 4"	15'			15 500	20 347	1 GE J47-GE-33 @ 5,500 lb
	F-100	Super Sabre	Fighter	1	39'	45'	14'					1 P&W J57 P 7 @ 10 000 lb
	F-107		Fighter									
	T-28B		Trainer	2	40' 7"	32' 11"	12' 7"			8 000		1 Wr R1820 @ 1 425 hp
	FJ-3	Fury	Fighter	1	37' 1"	37' 7"	13' 8"				18 000	1 Wr J65 @ 7 200 lb t
	FJ-4	Fury	Fighter	1	39' 1"	37' 6"	12' 8"				19 000	1 Wr J65-W-4 @ [illegible]800 lb t.
Northrop Aircraft, Inc. Hawthorne, Calif	F-89D	Scorpion	A-W inter	2	59' 8"	53' 6"	17' 6"	600+			40 000+	2 All J35-A-35
Republic Aviation Corp Farmingdale, L. I., N. Y.	F-84F	Thunderstreak	Fighter-bomb.	1	33' 6"	43' 4"	14' 4"				25 000	1 Wr J65 W-3 @ 7 200 lb t
	RF-84F	Thunderflash	Recon	1	33' 6"	47' 6"	15'					1 Wr J65 W-3 @ 7 200 lb t
	XF-103		Interceptor									1 Wr J67 @ 15,000 lb t.
	XF-105		Fighter-bomb.									2 All J71 A-7 @ 10 000 lb.t

T		PERFORMANCE					ARMAMENT	CHRONOLOGY				REMARKS
	Normal fuel cap., gal.	Maximum speed, mph	Initial rate of climb, fpm	Stall speed, dirty, mph	Service ceiling, ft	Combat radius, mi	Number, type and designation	First flight of prototype	First production contract	First deliveries to service	First flight, first prod	
	134 50	205 180	1 230	67 54	20 000 20 000		None 2 x .30-cal. mg., 6 rockets	Nov '46 Dec '46		Jan 52 Aug. 56	Jan. 53 Oct 53	
		600+			40 000+	2 000+	2 x 20-mm. cannon, 20 000 lb. of bombs, GAM-63 Rascal	Dec 47	Sept 48	Oct 51	June 50	Also reconaissance version RB-47E, 34 in longer
		600+			50 000+			Apr 52	Mar 51		Aug. 54	
0 hp.	6 100	575	1 200	107	28 000		None None	Nov 48	July 45 Sept. 54	1947	Mar 47	Developmnt based on 707 prototype
		400 180					Bombs & rockets	Sept 54				Improved L-16
lb t.		650+	13 000		40 000		4 x 20-mm. cannon				Dec. 51	
p	30,000	435+			45 000	5 000	16-20-mm cannon	Aug 46	Aug. 47	Aug 47	Aug. 47	Delta wing, podded engines
h l		1 000 M>1					GAR-68 Falcon missile	Oct. 53				
1 hp	1 550	390	1 370	92	24 000		None	Sept 49				T-29D in equivalent for bombardier-training
1 p	1 550	312	1 410	93	24 500		None	Mar 54	1952	1954	1954	
1 hp	1 730	295	1 430		24 500		None	Dec 54				Avienc test bed 340 airframe
	1 730	566	2 180		36 300		None	May 54		1954		
0 hp	1 730	314	1 220	85			None	June 54			June 54	Equivalent to comm. 340 Convair-Liner
		500+		0			None	Aug 54				Prototype VTO
								Apr 53				Hydroski landing gear
		350+					None	Apr 50			Oct 54	R3Y 1 is 142' 6" long
	4 650						2 x 20-mm cannon	June 54	Aug 53	Nov 54	Jan 55	USAF version of original A3D design for Navy
	4 499						2 x 20-mm. cannon	June 54	May 53			
hp	11 053	319	1 130	108	20 950	1 900	None		Sept 50	Apr 53	Feb. 53	
							4 x 20 mm. cannon					Convertible to 12 configurations AD-5 is similar
								Oct 52				
								1954				Smallest A-bomb carrier
								Jan 51				Holdr 100 km. closed-circuit record 728.11 mph
hp	2 624	360		105		2 100	None		Jan 52	Feb. 53	Nov 52	
0 hp	1 514	260					None		Oct. 53	Oct 54	Aug. 54	Original design was Chase Aircraft's
							4 x 20-mm cannon	Jan 54				Improved -B more wing area & cambered section
							Air to-air missiles	July 54				Supersonic in level flight
							Sonobuoys	Dec 52				Combines hunter-killer functions
-p-	1 275	275	1 400				None					Also Navy UF-1 & Coast Guard UF-1G
		M>1			60 000			Feb 54				Straightwing very thin section
	860	560	3 450		45 000+	480	2 x .50-cal. mg.	Mar 48	Oct. 47	Aug 48		Also Navy TV 2
	7 750						None				July 51	Equivalent of comm versions; also Navy R7V-1
	8 750	300					None					
							None	Aug 54	Sept. 52		1955	Production of Lockheed, Marietta, Ga.
												Navy development
							None					Prototype VTO
hp.							6 x 20-mm. cannon	May 45				Holds non-stop record (11 236 mi.)
		300			22 000							
							None	Sept 54				"World's fastest prop-driven transport"
	6 750											box tons of radar used by Navy as command
	6 750	360+					None					centers; more than 24-hr endurance
		515+			45 000+		8 x .50-cal mg., bombs, oxyalin and rockets			Aug. 53		B-57A was test vehicle, RB-57 is recco B-57C is transition trainer
hp	3 035	250				2 870		Aug 53		June 54		
		600+			40 000+		Mines				1954	Camera pod mounts in bomb bay in PK version
h.t.							Atomic stores 4 x 20-mm cannon rockets	Sept. 54	Sept. 52			Long-range strategic fighter
l		650+			45 000+	500	24 x 2 75-in rockets	Dec 49		Mar 52		
t.		650+			45 000+	600	6 x .50-cal. mg.					
		610+			45 000+	1 150	1 x 20- mc M39 cannon	Apr 53			Sept. 53	
t.		650+			45 000+	500+	4 x 20- m. M39 cannon	July 54				
l		755			50 000+	500+	20-mm cannon	May 53	Oct 51	Sept 54		Redesignated from F-100B
		346	3 830		37 000		.50-cal n g 2 75-in rockets	Apr 53	Sept 54			
					45 000		4 x 20-mm. cannon	July 53				
		605+			45 000+		4 x 20-mm cannon	Oct 54				
		600+			52 000+		104 x 2 75-in. rockets	Oct 51	Apr 51	Apr 53	Jan 53	Armament in wingtip pods
		650+			45 000+	1 000	6 x 50-cal mg 24 x 5" rockets	June 50	Apr 51	Mar 53	Nov 52	
		650+			15 000+	1 000	4 x 50-cal. mg.	Feb 52	Apr 51	May 54	Sept. 53	Bypass arrangement for regime in ramjet

U. S. Missiles and Pilotless Aircraft

Basic Missile Data					Physical Data				Powerplant	Launcher	Performance		Current Status			Remarks
Category	Name	Designation	Manufacturer	Cognizant service	Overall length less booster, ft.	Overall span of fins or wings, ft.	Body diameter ft.	Takeoff wt. plus booster, lb.	Manufacturer, type and designation	Manufacturer, type and designation	Maximum speed, Mach number	Maximum range, mi	Research	Development	Production	Service use	
Air-to-air	Falcon	GAR-98	Hughes	USAF					1 rpr	Nmr				✓	✓		Tested on Convair F-102
	Oriole	XAAM-N-4	Martin	Navy					1 spr	None		5		✓			Canceled in mid-1954
	Sidewinder	XAAM-N-7	Philco	Navy										✓	✓		
	Sparrow 1	XAAM-N-2	Douglas	BuAer					1 spr.	None		3		✓	✓	✓	Sperry is prime contractor
	Sparrow 2	XAAM-N-3		BuAer					1 rpr.					✓			
	Sparrow 3	XAAM-N-4		BuAer					1 spr.					✓			
Air-to-surface	Bullpup	XASM-N-7	Martin	Navy	11		1		1 spr	None				✓	✓		
	Dove	XASM-N-4	East Kodak	Navy											✓		
	Gorgon 5	XASM-N-5	Martin	Navy											✓		
	Rascal	GAM-63	Bell Aircraft	USAF	20		4 5		3 Bell lpr	None air-launched	1 5	100		✓	✓		Bell has systems contract
Air-to-underwater	Petrel	XAUM-N-2	Fairchild	BuOrd					1 Fair J44 tj	None air launched	0 7				✓		For anti-sub use
Surface-to-air	Bomarc	IM-99	Boeing	USAF				5 000	2 Mar rj	1 Aero. spc.	2 5			✓	✓		Boeing has systems contract
	Lob		East Coast	ArmyOrd			25		1 GC spr	Nmr					✓		
	Nike 1	XSAM-A-7	Douglas	ArmyOrd	20		1		1 Aero lpr	1 Hwr spr	2 0	16		✓	✓	✓	More than 100 units near 13 cities
	Talos	XSAM-N-6	McDonnell	BuOrd										✓	✓		Originated JHU/APL as Bumblebee
	Terrier 1	XSAM-N-7	Convair	BuOrd					1 lpr	1 spr		20			✓	✓	
Surface-to-Surface	Atlas	SM-	Convair	USAF					NAA lpr								Intercontinental ballistic missile
	Corporal	XSSM-A-17	Firestone	ArmyOrd	40		3 5	12 000	1 JPL lpr	None					✓	✓	Originated at JPL
	Honest John		Douglas	ArmyOrd	21	8	2 5		1 Hrec spr	None					✓	✓	Guided range comparable to long-range artillery
	Lacrosse			ArmyOrd					1 spr						✓		Close-support missile
	Matador	TM-61	Martin	USAF	39 5	28	8 4 5	12 000	1 All J33-A-37 tj	1 spr	0 9	000		✓	✓	✓	Cost $90 000 each
	Navaho	SM-64	North American	USAF					2 Wr rj	NAA lpr	3 0			✓			At least three versions
	Redstone		Chrysler	ArmyOrd					1 lpr	Nmr				✓	✓		Tactical missile
	Regulus	XSSM-N-8	Chance Vought	BuAer	33	21	4 5	14 522	1 All J33-A-14 tj	2 rpr					✓		Test vehicles have landing gear
	Snark	SM-62	Northrop	USAF	32		4 5		1 All tj	Sled launcher	0 9				✓	✓	Development has P&W J57 tj
Target		TQ-1B	Radioplane	USAF	17 3	14 3			1 R R Soar tj					✓	✓		
	Firebee	Q-2	Ryan	USAF	17 3	11 2		1 848	1 Fair J44 R-20 tj	1 Aero. X102F2 spr	0 9	1 5			✓	✓	Also XM-21 (Army) and KDA-1 (Navy)
									1 Con 169 T-19 tj.								
		OQ-19D	Radioplane	USAF	12 3	11 5			1 McC piston eng.	Catapult	0 3				✓	✓	
	Pogo			BuOrd	14 0				1 X220AS spr	1 spr				✓			Extreme-altitude target
Research	Aerobee		Aerojet	USAF Navy	20		1 ft	1 600	1 Aero lpr	1 Aero rpr					✓	✓	
	Viking	RTV-N-12b	Martin	NRL	42-46	9-13	3 ft		1 RMI XLR10-RM-2 1 pr	None					✓	✓	Holds alt. record of 158 mi

Abbreviations

Aero—Aerojet-General Corp.
All—Allison Division
ArmyOrd—Army Ordnance
BuAer—Navy Bureau of Aeronautics
BuOrd—Navy Bureau of Ordnance
Con—Continental Motors Corp
Fair—Fairchild Engine Division
GC—Grand Central Aircraft
Hurc—Hercules Powder Co
JHU APL—Johns Hopkins Univ Apalie Physics Lab
JPL—Jet Propulsion Lab, CalTech
lpr—Liquid-propellant rocket
Mar—Marquardt Aircraft Co
McC—McCulloch Motors
NAA—North American Aviation Inc.
NRL—Naval Research Lab
P&W—Pratt & Whitney Aircraft Division
tj—Ramjet
RMI—Reaction Motors, Inc.
R-R—Rolls-Royce, Ltd.
spr—Solid-propellant rocket
tj—Turbojet
USAF—United States Air Force
Wr—Wright Aeronautical Division

U.S. Commercial Transports

Manufacturer	Model	Name	No. of crew	No. of passengers	Cargo capacity, lb	Number, designation and max/min rating of powerplants	Maximum speed, mph	Best cruise speed, mph	Landing speed, flaps and landing gear down, mph	Engine-out en route climb, fpm	CAA field length (takeoff), ft.	CAA field length (landing), ft.	Maximum still-air range, mi	Weight empty, lb	Maximum gross weight, lb	Maximum landing weight, lb	Wingspan, ft.	Overall length ft.	Maximum height, ft.
Boeing Airplane Co	707		2-3			4 P&W JT3-P @ 10 000 lb t.		550							190 000		130'	128'	38' 3"
Convair Division General Dynamics Corp	340	Convair Liner	3	44	13 000	2 P&W R2800-CB-16 @ 2 400 hp.	314	334	86	1,220	4 675		1,360	29 488	47 000	46 500	105' 4"	79' 2"	28' 2"
Douglas Aircraft Co., Inc.	DC-6A	Liftmaster	5-5	6	30 500	4 P&W R2800-CB 17 @ 2 500 hp	370	318	97	490	5 100	3 160	3 000	81 316	107 000	85 200	117' 5"	100' 6"	25' 8"
	DC-6B	(domestic version)	5	54	18 780	4 P&W R2800-CB 16 @ 2 400 hp.	370	318	95	490	5 600	4 295	1 720	85 357	100 000	85 000	117' 5"	100' 6"	28' 8"
	DC-6B	(overwater version)	7*	89	11 930	4 P&W R2800-CB-17 @ 2 500 hp.	370	315	97	483	6 100	5 100	5 000	88 340	107 000	88 200	117' 5"	106' 0"	28' 8"
	DC-7	(domestic version)	4	66	12 310	4 Wr 972TC18DA4 @ 3,250 hp.	410	370		481	5 830	5 510	3 825	84 480	122 200	97 000	117' 6"	108' 11"	28' 7"
	DC-7B	(overwater version)	7	55-58	17 730	4 Wr 972TC18DA4 @ 3,250 hp.	405	381		516	6 560	5 990	5 000	93 673	125 000	102 000	117' 6"	108' 11"	28' 7"
	DC-7C	Seven Seas	7	58-97	18 100	4 Wr 988TC18EA1 @ 3,400 hp	406	359		507	4 040	5 400	5 010	72 643	120 000	107 000	127' 6"	112	31' 10"
Lockheed Aircraft Corp	1049C	Super Constellation	5-11	47-99		4 Wr 972TC18DA3 @ 3,250 hp.	370	335	100	765	6 010	6 830	5,840	73 616	137 500	113 000	123'	113' 8"	24' 8"

Abbreviations: P&W — Pratt & Whitney Aircraft. Wr — Wright Aeronautical Division. lb.t. — Pounds of thrust. hp. — Horsepower

Footnotes: * Figure is sea level rate of climb. † Includes two cabin attendants.

U.S. Gas Turbine Engines

Manufacturer	Designation	Type	No. compressor stages	No. turbine stages	No. combustors	Max. power @ S. L.	Specific fuel consumption at max. power lb./hr./lb. or sshp	Compression ratio at max. rpm.	Max. envelope diameter in.	Max. envelope length, in.	Dry weight, less hp/prop, lb.	Remarks
Boeing Airplane Co.	T50	TFF	1	2	2	210 eshp	1 3	3 0	23	46	240	Flown in Cessna XL-19B and Kaman copters
	502-10B	CFF	1	2	2	270 eshp	1 02	4 25	23	43	245	
Curtiss-Wright Corp. Wright Aeronautical Division	J65 W 1 -2,-3 -5	AFJ	13	2	1	7 220 lb. t						4 rated at 7 800 lb t.
	J67	AFJ				15 000 lb t.						
	740	AFF										
Fairchild Engine & Airplane Corp. Fairchild Engine Division	J44-R 1		1	1	1	1,000 lb. t	1 50		22	89	345	Flown in Ryan Firebee Bell VTOL data applies to R-12 14 20 & 24
General Electric Co. Aircraft Gas Turbine Division	J47-GE-25	AFJ	12	1	8	9 000 lb. t.		5 38	37	145	2 554	Powers Boeing B-47B & E RB 47E
	J47-GE-33	AFJ	12	1	8	7 800 lb. t		5 35	37	228	3 196	Powers NAA F-86D has afterburner
	J73-GE-3	AFJ	12	3	10	9,000 lb t.			37	148		Powers NAA F-86H
	J79	AFJ										
General Motors Corp. Allison Division	J33-A 18A	CFJ	1	1	14	4 600 lb. t	1 14	4 4	51	107	1 765	
	J33-A-35	CFJ	1	1	14	4 600 lb t.	1 14	4 4	51	107	1 820	
	J33 A-37	CFJ	1	1	14	4 600 lb t.	1 14	4 25	50	109	1 750	
	J35-A-35	AFJ	11	1	8	5,200 lb t.	1 00	5 2	37	106	3 630	7 400 lb t w/afterburners lc = 2.25 Commercial version is Model 501 D10 Powers F3H 3-66 and F8U
	T56-A 1	AFP	14	4	6	3 750 eshp	0 54	8 5	39	148	1 010	
	J71	AFJ				10,000 lb t						
United Aircraft Corp. Pratt & Whitney Aircraft Division	J48	TFJ	1	1	—	7 200 lb t						
	J57	AFJ			—	10 000 lb t						
	J75	AFJ			—	15,000 lb t.						
	T34	AFP	13	3	8	5 500 eshp.		6 7	34	135	2 564	
	T37				—	15 000 eshp						
	JT-7 H	AFJ				7 250 lb. t.	1 14		51	110	2 880	
	PT2C-3	AFF				5 000 eshp.	0 53		34	137	2 550	
Westinghouse Electric Corp. Aviation Gas Turbine Division	J34-WE-34	AFJ	11	2	1	3 250 lb. t.	1 00	4 1	24	120	1 233	
	J40-WE-6	AFJ				7 500 lb. t.			40	186	3 000	
	J40-WE-8	AFJ				7 500 lb. t.			40		3 300	
	J46	AFJ				4 000 lb. t.						

Abbreviations: AFJ Axial-flow turbojet. AFP — Axial flow turboprop. CFJ — Centrifugal-flow turbojet. eshp. — Equivalent shaft horsepower. lb t. — Pounds thrust.

U. S. Civil and Military Rotary-Wing Aircraft

General Data						Dimensions			Weights			Powerplant		Performance			Remarks
Manufacturer	Model No.	Military designation	Number of crew	No. of passengers	Cargo cap. lb.	Rotor dia. ft	Max. length (blades unfolded), ft.	Overall height to top of rotor, ft.	Weight empty lb.	Normal gross wt. lb.	Max. gross wt. lb.	Manufacturer and designation	Max. rating, hp or eshp. per engine	Max. speed, mph at altitude ft	Hovering ceiling in ground effect ft.	Still-air range mi.	
Bell Aircraft Corp.	201	XH-13F	1	2								1 Con. Artouste 1					
	47G	H-13G	1	2	610	35' 1"	41' 5"	9' 5"	1,4[illegible]	2,350	2,350	1 AM 6V4-200-C32	200	100/S.L.	3,000	212	
	47G		1	2	400	35' 1"	41' 5"	9' 5"	1,555	2,350	2,350	1 Lyc VO-435	200	100/S.L.	10,000	200+	Derated engine
	47H		1	2	525	35' 1"	41' 5"	9' 4"	1,505	2,350	2,350	1 AM 6V4-200-C33	200	100/S.L.	5,000	200+	
	47J		1	3	522	35' 1"	41' 5"	9' 4"	1,620	2,550	2,550	1 Lyc VO-435	200				Derated engine
	61	HSL-1	4	...	—	51' 6"	70' 0"	14' 6"		—		1 P&W R2800-50	1,900	135/S.L.			Twin-tandem rotors, derated engine
	200	XV-3	1	...		24' 0"	30' 6"	13' 0"	...	...		1 P&W R985		175/S.L.			Convertiplane twin rotors on wingtips
	212	—	1		300					—					8,000		
Bensen Aircraft Corp.	B-4		1	0	60	15' 0"	15' 0"	4' 11"	90	272		2 SR-1 ramjet	40	75/S.L.			
	B-5		1	0	75	18' 0"	18' 0"	5' 1"	86	336		None		60/S.L.			Gyro-glider
	B-6		1	0	75	20' 0"	20' 0"	5' 8"	103	353		None		60/S.L.			Gyro-glider
Brantly Helicopter Corp.	B2		1	1	525	23' 0"		6' 10"	825	1,350		1 Lyc O-320					
Cessna Aircraft Co.	CH-1		1	2	200	35' 0"	42' 5"	9' 0"	1,900	2,[illegible]	[illegible]	1 Con. FSO-470	260	150+/S.L.	8,200+		
Convertawings, Inc.	A	—	1	0		19' 8"				2,200		2 Con. C-90	90				Four-rotor convertiplane
Doman Helicopters, Inc.	LZ-5	YH-31	1	6	1,200	48' 0"		10' 3"	3,200	5,000	5,000	1 Lyc. SO-580-D	400	90/1,000	7,000	240	
Flettner Aircraft Corp.	—	—	—	40													Design studies on a family of large cargoers
Glenview Metal Products Co.	B S		1	1	—	32' 0"	35' 7"	7' 8"	1,100	1,635	—	1 Lyc. O-290-D2	140	118/2,000	4,200	229	B has semi-conventional control. S has [illegible]
Gyrodyne Co. of Amer., Inc.	GCA-2C		2	4		48' 0"	48' 0"	14' 8"	3,600	6,150	6,800	1 P&W R985	450	87/S.L.	—	290	Co-axial configuration
		XRON-1	1	0								1 BPI					
Hiller Helicopters	12-H	H-23B	1-0	1-2	440	35' 0"	40' 8"	9' 6"	1,628	2,400	2,500	1 AM 6V4-200-C33	200	84/S.L.	3,200	140	
		H-32	1	1	380	23' 8"	24' 8"	7' 10"	630	1,080	1,280	1 Hiller 8RJ2B	38[1]				HJ-1 and HOE-1 also
Jacobs Aircraft Engine Co.	104		1	4	680	38' 0"	32' 11"	10' 10"	2,380	3,470	3,470	1 Jacobs R755EM	350	175/S.L.	—	300	Convertiplane
Kaman Aircraft Corp.	K-240	HTK-1	2	1		42' 0"	42' 0"	12' 6"				1 Lyc. O-435	240				
		HTK	2	1		42' 0"	42' 0"	12' 6"				2 Boeing 502-2	150				Development project only
	K-225		1	2		40' 0"	40' 0"	11' 6"				1 Boeing 502-2	160				Development project only
		HOK-1	2	3		47' 0"	47' 0"	12' 6"				1 P&W R1340	600				
Kellett Aircraft Corp.		KH-15	1	0								2 RMI rockets	15[1]				
McDonnell Aircraft Corp.	82	XV-1	1									1 Con.	500				Convertiplane
Piasecki Helicopter Corp.	PD-18	HUP-2	1	5-6	1,500	35' 0"	56' 11"	13' 2"	4,100	5,750	6,100	1 Con. R975-42	600	105/S.L.	7,000	490	
	PD-18	H-25A	1	5-6	1,500	35' 0"	56' 11"	12' 6"	3,928	5,750	6,100	1 Con. R975-42	550	105/S.L.	7,000	490	Navy equivalent is HUP-3
		HUP-4	1									1 Wr. R1300-3	700				
	PD-22	H-21A	1-0	14		44' 0"	86' 4"	15' 0"	8,300	11,200	14,300	1 Wr. R1820-103	1,150	140/S.L.	14,000	480	Power limited by transmission
	PH 42	H-21B	1-0	20		44' 0"	86' 4"	15' 0"	8,800	13,300	15,000	1 Wr. R1820-103	1,425	140/S.L.	9,300	400	
	PH 42	H-21C	1-2	20	1,300	44' 0"	86' 4"	15' 6"	8,500	13,200	18,000	1 Wr. R1820-103	1,425	140/S.L.	9,100	400	
		YH-16	0-3	40		82' 0"	134' 0"	31' 0"		30,000		2 P&W R2180	1,650			—	YH-16A has Allison T56s
Rotor Craft Corp.			1	0								Rocket					
Sikorsky Aircraft Div.	S-55	H-19A	2	10	1,800	53' 0"	62' 7"	13' 4"	4,795	7,200	7,200	1 P&W R1340	600	101/S.L.	6,200	405	Also H-19C, HO4S-1, HRS-1 & 2
		H-19B	2	10	2,200	53' 0"	62' 7"	13' 4"	5,945	7,500	7,900	1 Wr. R1300-3	700	110/S.L.	12,500	385	Also H-19D, HO4S-2, HO4S-3, HRS-3
	S-56	HR2S-1	8								28,500	2 P&W R2800-50	1,900		—	—	Also Army H-37A
	S-58	HSS-1	2									1 Wr. R1820-84	1,525				Also Army H-34A
	[illegible]	XH-39	2	2	800	35' 0"	41' 7"	9' 8"	[illegible],200	3,500	3,500	1 Con. Artouste II	400	140/S.L.	6,500	255	Holds speed (156 mph) and altitude records (24,500 ft.)
Transcendental Aircraft Corp.	1-G		1			47' 0"						1 Lyc. GO-290	160				Convertiplane test vehicle

Engine abbreviations
AM—Aircooled Motors
BPI—Barmotive Products Inc.
Con.—Continental Motors Corp.
Lyc.—Lycoming Division
P&W—Pratt & Whitney Aircraft
RMI—Reaction Motors, Inc.
Wr.—Wright Aeronautical Division

Footnote
1—lb. thrust

U. S. Personal and Business Aircraft

AIRCRAFT BASIC DATA			DIMENSIONS				WEIGHTS		POWERPLANT	PERFORMANCE							
Manufacturer and address	Designation	No. of seats	Overall span ft	Overall length ft.	Max height, 3-pt. ft.	Gross wing area, sq ft	Weight empty, lb	Normal gross wt., lb	Number, make, model and max. rating	Normal fuel cap., gal	Max. speed mph	Landing speed, mph	CAA field length (takeoff) ft.	CAA field length (landing) ft.	Max. range mi.	Price, FAF $	Remarks
Aerocar Inc. *Longview Wash.*	Flying Auto.	2	34	21	[illegible]	190	1 400	1 850	1 Lyc O320 @ 135 hp	24	110+	50	500	400	300	25 000	
Aero Design & Eng. Co. *Bethany Okla.*	Aero Commander 560	7	44	35' 3"	14' 9"	243	3 870	6 000	2 Lyc GO 480-B @ 275 hp.	156	206	55	1 100	1 050	1 650	58 500	
Aero-Flight Aircraft Corp *Long Beach Calif*	Streak 135	2	25' 3"	22' 4"	8' 3"			1 605	1 AM @ 165 hp	45	215	57	429	480	1 050		
Baumann Aircraft Corp *Pacoima Calif*	Brigadier	5	44	29'	11'	309	2 700	4 000	2 Con C146-2HP @ 145 hp	72	190	57	850	500	750	44 570	
Beech Aircraft Corp. *Wichita 1, Kan*	Super 18 (E18S)	5	48' 8"	35' 2"	9' 5"	349	5 970	9 300	2 P&W R985-AN14B @ 450 hp.	286	234		1 800	1 700	1 455	78 975	
	Bonanza F35	4	32' 10"	25' 2"	6' 6"	178	1 695	2 750	1 Con E185-11 @ 205 hp	39	190	55	980	227	1 180	18 990	Con E225 is optional
	Twin Bonanza	5	45' 3"	31' 5"	11' 4"	277	[illegible]	6 000	2 Lyc GO 480-F6 @ 275 hp.	134	210	66	905	645	1 100	72 000	
Bee Aviation *San Diego Calif*	Wee Bee	1	18' 0"	14' 2"	3' 0"	44	210	410	1 Kiek. 4M5-35 @ 35 hp.	2.5	82	40	500	500	50		Prone pilot
	Honey Bee	1	28' 0"	19' 10"	7' 5"	86	618	850	1 Con A65 @ 65 hp	8.5	100	45	700	500	240		
	Queen Bee	4	32' 10"	22' 1"	8' 3"	130	1 190	2 100	1 Lyc O320 @ 150 hp	30	175	55	700	700	800	15 000	
Bellanca Aircraft Corp. *New Castle Del.*	Cruisemaster	4	34' 2"	23' 0"	6'	142	1 580	2 600	1 Lyc O435A @ 170 hp	40	180	43			600		
Call Air *Afton, Wy*	Super Cadet	2	33' 6"	23' 5"	7' 4"	174	1 100	1 650	1 Lyc O320 @ 150 hp	20	125	41	450	400	540	5 575	
	CallAir A5	2	35' 9"	23' 5"	7' 5"	182	1 100	1 550	1 Lyc O320 @ 150 hp	25	114	45	450	400	470	6 775	
	CallAir Duster	1	33' 1"	23' 5"	7' 5"	182	850	1 550	1 Lyc O320 @ 150 hp	28	115	45	550	400	470	5 995	
Cessna Aircraft Co. *Wichita Kan*	170	4	36' 0"	25' 0"	6' 7"	175	1 205	2 200	1 Con C145-2 @ 145 hp	42	140+					8 295	
	180	4	36' 0"	25' 0"	7' 5"	175	1 480	2 550	1 Con O470-J @ 225 hp	60	165+					12 950	
	310	5	35' 0"	27' 0"	10' 5"	175	2 850	4 600	2 Con O470-B @ 240 hp.	100	220+				1 000	49 950	
Champion Aircraft *St Paul Minn*	Champion	2	35' 2"	21' 0"	6' 10"	170	800	1 450	1 Con. C90 @ 90 hp.	18	150	44					
Colonial Aircraft Corp *Deer Park, L. I., N. Y.*	Skimmer	3	34' 0"	23' 6"	8' 10"	151	1 350	2 000	1 Lyc O290 D @ 135 hp.	38	125	60			700		Amphibian
Custer Channel Wing Corp *Hagerstown Md*	CCW-5	6	41' 2"	28' 3"	10' 10"		2 900	5 400	2 Con SO-470B		200	15				60 000	Price is estimate
Helio Aircraft Corp *Norwood Mass.*	Courier	4	39' 0"	30' 0"	8' 10"	231	1 620	2 800	1 Lyc GO435-C2B @ 260 hp.	61	157	30	220	220	500	24 500	
Lamson Aircraft Co. Inc. *Yakima, Wash.*	Air Tractor	1	36' 7"	26' 5"	11' 3"	330		5 500	1 P&W R985 @ 450 hp	90							Spray/duster
Mercoupe Aircraft of Fla. Inc. *Melbourne Fla*	Meteor Mk. 2	4	33'	26'	5' 1"	165	1 750	3 100	1 Lyc O320 @ 150 hp.	90	160	52	300	250	800	25 000	
Mooney Aircraft, Inc. *Kerrville Tex*	Mite	1	26' 11"	17' 8"	6' 3"	90	500	850	1 Con A65-8 @ 65 hp.	15	142	46			420	3 400	
	Mark 20	4	35' 0"	23' 2"	8' 3"	167	1 335	2 450	1 Lyc O320 @ 150 hp	30	177	50			1 000	12 500	
Piper Aircraft Corp. *Lock Haven, Pa*	Super Cub	2	35' 4"	22' 3"	6' 8"	179	830	1 750	1 Lyc O320 @ 150 hp	36	130	43			460	5 445	
	PA 18A	1	35' 4"	22' 3"	6' 8"	179	930	2 070	1 Lyc O320 @ 150 hp	36	128	45			400	5 595	Agricultural duster
	Tri Pacer	4	29' 4"	20' 7"	8' 4"	145	1 100	2 000	1 Lyc O320 @ 150 hp.	36	135	49			480	6 825	
	Apache	4	37' 0"	27' 1"	9' 6"	204	2 180	3 500	2 Lyc O320 @ 150 hp	72	180	52			[illegible]	32 500	
Stits Aircraft *Riverside Calif*	Playboy SA3A	1	22' 2"	17' 4"	5'	91	600	902	1 Con C85 @ 85 hp	14	150	46	150	300	400	3 350	
	Playboy SA3B	2	23' 8"	18' 0"	5'	100	775	1 280	1 Lyc [illegible] @ 135 hp	20	160	50	175	300	500	3 950	
	Executive	3	25' 6"	18' 9"	5' 10"	120	900	1 450	1 Lyc O320 @ 150 hp	20	175	50	150	300	450	5 000	
Streak Aero Corp. *Hollydale Calif*	Streak 225	2	25' 3"	22' 6"	8' 1"			1 605	1 Lyc O435 A2 @ 225 hp.	78	238	51	400	500	1 350		
Temco Aircraft Corp *Dallas 2, Tex*	Riley 55	4	33' 8"	27' 2"	9' 7"	178	2 350	3 000	1 Lyc O340-A1A @ 170 hp.	105	180	60	1 150	1 000	900	27 500	Navion conversion
Transland Company *Los Angeles Calif*	Ag-2	1	42' 0"	26' 0"	9' 5"	210	3 650	5 200	1 P&W R985 @ 450 hp	50	150	48	1 200	1 000		15 000	Farm & forest duties

Abbreviations
AM — Aircooled Motors
Con — Continental Motors Corp
Kiek. — Kiekhaefer
Lyc — Lycoming Division
P&W — Pratt & Whitney Aircraft

Note
All data were supplied by the manufacturers; prices and other figures may be subject to change. In particular, CAA field length figures appear to be in some cases only rolling distances on the ground.

U. S. Reciprocating Engines

Manufacturer and Address	Designation	No. of cylinders	Cylinder arrangement	Propeller drive	Power Ratings: Max. takeoff power (hp.) — SL	At rpm	Normal cruise power (hp.)	At rpm	At altitude (ft.)	Octane	Diameter (without cowling)	Blower ratio	Gross weight dry (lb.)
Aircooled Motors, Inc. *Syracuse, N. Y.*	4A4-95-B3	4	Ho	Direct	90	2,300	—			80			[1]202
	4A4-100-B3	4	Ho	Direct	100	2,550	—			80			400
	6A4-150-B3	6	Ho	Direct	150	2,600	—			80			275
	6A4-165-B3	6	Ho	Direct	165	2,800	—			80			279
	6V4-178-B32, B33[1] O335-3,-4	6	Vo	Direct	178	3,000	—			80			291
	6AG4-185-B12	6	Ho	G .822:1	185	3,100				80			292
	6A4-200-C6	6	Ho	Direct	200	2,100	—			91			307
	6V4-200-C32[1], C33[1] O335-5,-6	6	Vo	Direct	200	3,100				91			297
	6VS-245-B16F[1] O425-1	6	Vo	Direct	245	3,275				80			272
Continental Motors Corp. *Muskegon, Mich.*	A65-8F	4	Ho	Direct	65	2,300	—			73			170
	C85-12F	4	Ho	Direct	85	2,575				73			182
	C90-12F	4	Ho	Direct	95	2,625				80/86			180
	C125-2	6	Ho	Direct	125	2,600				73			257
	C145-2	6	Ho	Direct	145	2,700				80/86			263
	O315A	4	Ho	Direct	150	2,600				80/86			283
	E185	6	Ho	Direct	205	2,600				80/86			355
	E225-8	6	Ho	Direct	225	2,650				80/86			355
	O470-A	6	Ho	Direct	225	2,600				80/86			352
	W670-23	7	Rad	Direct	240	2,300				80/86			465
	GE300-2	6	Ho	G .60:1	300	3,160				80/86			431
Jacobs Aircraft Engine Co. *Pottstown, Pa.*	R755-A R755-11	7	Rad	Direct	300	2,200				80	44"		505
	R755-B	7	Rad	Direct	275	2,200				80	44"		505
	R755-EH	7	Rad		350	2,500	275	2,300		91/96	44"	6.5	768
Lycoming Division of Avco Mfg. Corp. *Stratford, Conn.*	820C9HD3 & 5 R1820-77A & 76B	9	Rad	G .666:1	1,425	2,700				100/130	54.95"	7.21[8]	[1]1,260
	853C7BA1[3] R1300-1A	7	Rad	G .4828:1	800	2,600				91/98	50.45"	7.21	1,000
	883C9HD1[3] R1820-103	9	Rad	Direct	1,425	2,700				100/130	54.95"	7.21[8]	1,250
	955C7BA1[3] R1300-2	7	Rad	Direct	800	2,600				91/98	50.45"	7.21	1,000
	966C9HE1[3] R1820-80	9	Rad	G .5625:1	1,475	2,700				100/130	54.95"	7.21	1,400
	967C9HE1[3] R1820-82	9	Rad	G .5625:1	1,525	2,800				115/145	55.74"	7.21	1,445
	971C7BA1[3] R1300-3	7	Rad	Direct	800	2,600				91/98	50.45"	7.21	1,080
	980C9HD1[3] R1820-86	9	Rad	D .563:1	1,425	2,700				100/130	54.95"	7.21[8]	1,285
	993C9HE1[3] R1820-84	9	Rad	Direct	1,525	2,800				115/145	55.74"	7.21[4]	1,460
	899C7BA1 R1300-4	7	Rad	D .4625:1	800	2,600				91/98	50.5"	7.21	1,092
	O235-C1	4	Ho	Direct	115	2,800	81	2,350	5,000	80	30.30x32"		236
	O290-D2	4	Ho	Direct	140	2,800	100	2,350	5,000	80/87	32.81x32.24"		260
	O320	4	Ho	Direct	150	2,700	112	2,450	7,000	80/87	24.88x32.24"		268
	O435-A	6	Ho	Direct	190	2,550	142	2,300	8,000	80/87	29.59x33.24"		372
	O435-H	6	Ho	Direct	200	2,800	142	2,250	8,000	80/87	24.09x32.24"		342
	O435-K1[3] O435-4	6	Ho	Direct	260	3,400	187	3,200	8,000	91/96	28.31x33.12"		366
	O435-V	6	Vo	Direct	260	3,400	180	3,100	5,000	80/87	33.12"		296
	GO435-C2	6	Ho	G .563:1	260	3,400	180	2,750	6,000	80/87	30.59x33.12"		422
	GSO435-9	6	Ho	D .642:1	300	3,400	195	2,750	10,000	91/98	32.30x33.12"	6.6	438
	GO-480	6	Ho	D .642	290	3,400	185	2,750	8,000	80/87	33.12"		432
	GSO480-B	6	Ho	D .642	340	3,200	230	2,750	18,000	100/130	33.12"	11.27	493
	GSO580-C	8	Ho	D .542:1	375	3,300	240	2,750	15,000	91/98	30.75x33.18"	7.81	592
	SO580-D[4]	8	Ho	Direct	400	3,000	270	2,750	11,000	100/130	40.75x33.18"	7.01	550
	GSO580-D O580-1	8	Ho	G .642:1	400	3,000	262	2,750	11,000	100/130	40.75x33.18"	7.01	597
	SO580-V O580-3	8	Vo	Direct	400	3,300	250	2,000	13,000	100/130	33.19"	7.0	568
Pratt & Whitney Aircraft Div. United Aircraft Corp. *East Hartford, Conn.*	R2000-D0	14	Rad	G .500:1	1,450	2,700	1,200	2,350	8,400	100/130	49.10"	—	1,585
	R2000-2SD13-G	14	Rad	G .500:1	1,450	2,700	1,200	2,550	8,000	100/130	49.10"		1,605
	R2800-CA3	18	Rad	G .450:1	2,400	2,800	1,800	2,600	5,000	100/130	52.80"		2,317
	R2800-CB3	18	Rad	G .450:1	2,400	2,800	1,800	2,600	8,500	100/130	52.80"		2,327
	R2800-CB4	18	Rad	G .450:1	2,500	2,800	1,800	2,600	8,500	108/135	52.80"		2,357
	R2800-CA18	18	Rad	G .450:1	2,400	2,800	1,800	2,600	6,000	100/130	52.80"		2,350
	R2800-CA15	18	Rad	D .450:1	2,400	2,800	1,800	2,600	6,000	100/130	52.80"		2,350
	R2800-CB16	18	Rad	G .450:1	2,400	2,800	1,800	2,600	8,000	100/130	52.80"	—	2,380
	R2800-CB17	18	Rad	G .450:1	2,500	2,800	1,800	2,600	8,000	108/135	52.80"	—	2,400
	R4360-CB2	28	Rad	D .375:1	3,000	2,700	2,600	2,550	5,000	108/135	55.00"	—	3,670
Wright Aeronautical Div. Curtiss-Wright Corp. *Wood-Ridge, N. J.*	745C18BA3	18	Rad	G .4375:1	2,500	2,900	1,800	2,300	12,100	100/150	55.6"	6.46[4]	2,780
	749C18BD1	18	Rad	D .4375:1	2,800	2,900	1,470	2,400	11,000	100/130	55.6"	6.46[4]	2,844
	826C9HD3 & 5 R1820-76A,-76B	9	Rad	G .666:1	1,425	2,700	—			100/130	54.95"	7.21[8]	1,380
	828C9HD4 R1820-101	9	Rad	D .5625:1	1,425	2,700				100/130	54.95"	7.01[8]	1,360
	836C18CA1 R3350-26WA	18	Rad	G .4375:1	2,700	2,900				115/145	55.6"	6.45[8]	2,840
	853C7BA1 R1300-1A	7	Rad	D .5625:1	800	2,600				91/98	50.45"	7.21	1,065
	883C9HD1 R1820-103	9	Rad	Direct	1,425	2,700				100/130	54.95"	7.21[4]	1,280
	956TC18DA1,2[8] R3350-30W	18	Rad	G .4375:1	3,250	2,900				115/145	56.6"	6.46[4]	3,409
	955C7BA1 R1300-2	7	Rad	Direct	800	2,600				91/98	50.45"	7.21	1,056
	966C9HE1 R1820-80	9	Rad	G .5625:1	1,475	2,800				100/130	54.95"	7.21	1,390
	967C9HE1 R1820-82	9	Rad	G .5625:1	1,425	2,600				115/145	55.74"	7.21	1,440
	971C7BA1 R1300-3	7	Rad	Direct	800	2,600				91/98	50.45"	7.21	1,080
	956C18CA1	18	Rad	G .4375:1	2,700	2,900	1,800	2,400	12,100	115/145	55.6"	6.46[4]	2,857
	952C7BA1	7	Rad	G .5625:1	800	2,600	600	2,130	10,400	91/98	50.45"	7.21	1,063
	975C9HE1	9	Rad	G .5625:1	1,475	2,600	600	2,400	12,000	100/130	54.95"	7.21	1,390
	972TC18DA1-2 R3350-34[7]	18	Rad	G .4375:1	3,250	2,900	2,010	2,400	11,400	115/145	56.6"	6.46[4]	3,514
	976C18CB1	18	Rad	G .4375:1	2,800	2,900	2,000	2,400	12,500	115/145	56.6"	6.46[4]	3,028
	977C9HE1	9	Rad	G .5625:1	1,525	2,800	800	2,400	12,200	100/130	55.74"	7.21[4]	1,400
	988TC18EA-2 R3350-EA1	18	Rad	G .4375:1	3,400	2,900	1,910	—	11,000	—	56.6"		3,600

Bmep. — Brake mean effective pressure.
G — Geared
Ho — Horizontally opposed
Rad — Radial
SL — Sea level
Vo — Vertically opposed.

[1] For helicopter installation.
[2] Manufactured under Curtiss-Wright license.
[3] Or 10.14:1
[4] Or 8.66:1
[5] Or 8.07:1

[6] 851TC18DB1 (R3350-30WA) is similar but has takeoff power (wet) of 3,500 hp. and dry gross weight of 3,445 lb. 988TC18DB1 (R3350-85) is similar to -30WA but weighs 3,438 lb. dry. Some have manifold absolute pressure regulator.
[7] Military engine rated at 3,700 hp. max.

USSR Military Aircraft

Category	Designation	Code name	No. of crew	Powerplant: Powerplant no., designation and power, each	Physical Data: Wingspan, ft.	Overall length, ft.	Gross weight, lb.	Armament	Performance: Max. speed, mph	Service ceiling, ft.
FIGHTER	MiG-15/1[1]	Falcon	1	1 x RD-45 @ 5,000 lb. t.	33.1	36.3	11,268	2 x 23-mm., 1 x 37-mm.	635	49,000
	MiG-15/2		1	1 x VK-1 @ 5,953 lb. t.	33.1	36.3	14,238	2 x 23-mm., 1 x 37-mm.	683	51,000
	MiG-17	Fresco	1	1 x VK-1A @ 6,750 lb. t.	33.1	38.3		2 x 23-mm., 1 x 37-mm.	690	51,000
	MiG-19		1	1 x VK-1 @ 5,953 lb. t.				1 x 23-mm., 1 x 37-mm.	678	50,000
	La-17	Type 31	1	1 x VK-1 @ 5,953 lb. t.	37.0	40.6		2 x 23-mm.	612	45,000
	La-11[1]	Fang	1	1 x ASH82FNV @ 1,850 hp.	32.6	28.6	7,700	3 x 20-mm.	420	40,000
	Yak-9P	Frank	1	1 x VK-107A @ 1,400 lb. t.	40.0	27.6	6,985	1 x 20-mm., 2 x 12.7-mm.	370	32,000
NIGHTFIGHTER	Il-26-1		2	2 x M-004X	60.0	60.0		4 x 23-mm.	650	45,000
	Il-26-2		2	2 x M-004X	60.2	59.6		6 x 23-mm.	660	45,000
GROUND SUPPORT	Il-10[2]	Beast	2	1 x AM-42 @ 2,000 hp.	45.0	40.0		Varied	335	27,000
	La-17-2		2	1 x VK-1 @ 5,953 lb. t.	37.0	41.0		4 x 23-mm.	600	40,000
MEDIUM BOMBER	Il-28	Butcher	3-4	2 x M-004X	72.0	60.0		4 x 23-mm.	580	45,000
	Il-28-2		3-4	2 x M-004X	62.2	75.8		6 x 23-mm.	600	45,000
	Tu-12C	Bosun	3-4	2 x M-001 Mk. 6	70.5	66.0	45,500	2 x 23-mm.	590	40,000
	Tu-2[1]	Bat	3-4	2 x ASH82FNV @ 1,400 hp.	61.6	45.3	26,224	5-7 m/g.	360	35,400
	Pe-2[1]	Buck	2	2 x VK-105R @ 1,100 hp.	56.3	41.4	18,730	2 x 12.7-mm., 7 x 7.62-mm.	340	29,000
HEAVY BOMBER	Tu-4	Bull	6-9	4 x radial @ 2,200 hp.	141.3	99.0			225	24,000
	Tu-200		10-16	6 x M-280 t. props[2]	236.0	200.0		10 x 20-mm.	465	30,000
	Il-43	Type 31	4-6	4 x M-220 t. props[2]	160.3	128.0	235,000	6 x 20-mm.	410	45,000
	Tu-37[1]	Bison	4	4 x axial @ 15,000 lb.	170.0	145.0	235,000		600	45,000
	Il-43B		4	4 x M-230 t. props[2]	164.5	132.6	210,000	8 x 20-mm.	450	45,000
	Il-39	Badger	3	2 x axial @ 15,000 lb.	170.0	130.0		6 x 20-mm.	640	45,400
TRANSPORT	Il-12B	Coach	2	2 x ASH-82 @ 1,700 hp.	106.0	74.3	37,380	None	250	
	Li-2[2]		2	2 x M-63 @ 1,000 hp.	90.0	64.5	26,000	None	225	24,000
	Il-18		3	4 x ASH82FNV @ 1,850 hp.	136.0	86.0		None	335	
	Tu-6(70)		4	4 x radial @ 2,200 hp.	141.3	119.0		None	215	
LIAISON	Yak-14(12)		2-3	1 x M-11 @ 145 hp.	39.6	27.8	2,645	None	122	20,000
	Po-2[3]		2	1 x M-11 @ 110 hp.	37.5	26.8	1,902	None	90	13,000
BASIC TRAINING	Po-6[3]		2	1 x M-11 @ 110 hp.	37.8	20.8	1,892	None	90	13,100
	Yak-18[3]		2	1 x M-11RFI @ 160 hp.	34.6	26.3	2,359	None	160	
ADVANCED TRAINER	Yak-11[1]		2	1 x ASH-21 @ 750 hp.	30.6	28.0	4,000	None	265	
FIGHTER TRAINER	U-MiG-15		2	1 x RD-45B	33.1	36.3	12,210	2 x 23-mm., 1 x 37-mm.	610	48,000
	Yak-15B	Type 26	2	1 x M-004	30.0	28.8		2 x 20-mm.	505	38,000
	Yak-23		1	1 x RD-500	30.0	29.0		2 x 20-mm.	630	38,000
BOMBER TRAINER	Il-27	Butcher	3	2 x M-004 Mk. 6	68.0	66.0			580	40,000
HELICOPTER	Mil-1	Type 32	2	1 x ASH-21 @ 550 hp.	46.6[5]		—	—		—
	Mil-3	Type 36	2	1 x ASH-82-1R @ 1,800 hp.						
FLYING BOAT	DST		3-4	2 x M-62R @ 1,000 hp.	101.6	62.0	27,000		190	

Footnotes:
1—Also used by East German Air Force.
2—First tested with radial engines as in Tu-4.
3—Also tested with 4 x M-004X turbojets.
4—Ten prototypes reported built.
5—Rotor diameter.

Abbreviations:
AM—A. A. Mikulin
ASH—A. D. Shvetsov
G—Mikhail Gurevich
Il—Sergei Ilyushin
La—Semyon Lavochkin
M—Motor (old designation)
Mi—Artem Mikoyan
Mil—Mikhail Mil
Pe—Vladimir Petlyakov
Po—Nikolai Polikarpov
Tu—Andrei Tupolev
Yak—Aleksandr Yakovlev

Current Russian practice is to designate aircraft by a combination of initials indicating the principal designer of the plane (e.g., MIG-15 is a design of Mikoyan and Gurevich).

Leading Foreign Aircraft Military and Civil

Manufacturer and address	Model designation	Aircraft name	Primary mission	Max. no. of crew	Max. no. of passengers	Overall wingspan, ft.	Overall length ft.	Maximum height ft.	Wing gross area sq. ft.	Weight empty lb.	Gross weight, lb.	Number, make, model and max rating of powerplants	Max speed mph
ARGENTINA													
Industrias Aeronáuticas y Mecánicas del Estado		Pulqui 2	Fighter	1	0	34 9	38 1	10 4		5 720	12 100	1 R-R Nene 2 @ 5 000 lb. t	654
	I.A. 35	Justicialista del Aire	Multi	11			45 8			7 700	12 500	2 IAR-19? Indio	220
AUSTRALIA													
Commonwealth Aircraft Corp. Pty Ltd	C.A. 25	Winjeel	Trainer	3	0	38 8	27 ?	9 0	249	3 290	4 235	1 P&W R985-SB-3 @ 450 hp.	187
	C.A. 27	Sabre Mk. 30	Fighter	1	0	37 1	37 ?	11 7	288	11 000	20 000	1 R-R Avon 20 @ 7 500 lb. t	700
Government Aircraft Factories		Canberra 20	Bomber	2	0	64 0	65 6	15 6	960		51 000	2 R-R Avon	...
CANADA													
Avro Aircraft, Ltd	CF 100 Mk. 4		AW F.tr	2	0	52 ?	52 ?	15 1	540		34 000	2 Orenda 8	...
Canadair Ltd.		Sabre 5	Fighter	1	0	37 0	37 0	14 0				1 Orenda @ 6,500 lb. t	700
De Havilland Aircraft of Canada, Ltd	D.H.C. 2	Beaver	Transport	1	6	48 0	30 0	10 5	250	2 580	5 100	1 P&W R985 @ 450 hp	163
	D.H.C. 3	Otter	Transport	1	14	58 0	41 ?	12 ?	375	4 348	7 600	1 P&W R1340 @ 600 hp.	161
FRANCE													
Constructions Aeronautiques du Bearn		Supercab	Pers.	1	1	27 10	18 0	5 5	108	880	1 350	1 Lor. @ 90 hp	175
Avions Boisavia	B-60	Mercury	Pers.	1	3	37 6	23 5	7 ?	151	1 130	2 575	1 Socema 4L02 @ 170 hp	155
S. A. des Ateliers d'Aviation Louis Breguet	763	Deux Ponts	Transport	3	107	140 8	94 9	31 4	1 985	58 150	113 500	4 P&W ? @ 2 100 hp	273
Avions Marcel Dassault	MD-452 II-C	Mystere 2	Fighter	1	0	38 4	38 7	14 0	326	11 100	16 400	1 Snecma Atar 101 D-1 @ 6 600 lb. t	600
	MD-452-IV A	Mystere 4A	Fighter	1	0	36 7	42 4	14 5	344	12 462	16 280	1 HS Verdon R 150 @ 7 700 lb. t	700
Avions Hurel Dubois	H.D. 32		Transport	3	44	147 0	72 2	21 8		24 425	30 000	2 P&W R1830 @ 1 200 hp	211
Farman		Monitor 3	Trainer	2	0	39 ?	25 0	7 2	161	1 232	1 894	1 Socema 4L20 @ 170 hp	150
Ets. Fouga & Cie	CM 170R	Magister	Trainer	2	0	37 3	33 0	9 2	186	4 260	6 100	2 Turb. Marbore 2 @ 880 lb. t	455
Soc. Franc. d'Etudes et de Construction de Materiels Aeronautiques Speciaux	1402	Gerfaut	Fighter	1	0							1 Snecma Atar	—
Rene LeDuc	O 21		Fighter	1	0	38 2	40 2	9 1		8 200	13 200	1 LeDuc ? @ 44 000 lb. t	655
Soc. Max Holste	M.H. 1521	Broussard	Pers.	1	6	45 0	28 5	6 3	273	3 190	5 500	1 P&W R985 @ 450 hp	175
Soc. Morane-Saulnier	M.S. 733	Alcyon	Trainer	3	0	37 0	31 2	11 4	226	2 830	3 800	1 Potez 6-D30 @ 240 hp.	161
	M.S. 760	Paris	Liaison	4	0	33 3	33 0	8 6	194	1 320	7 ?5	2 Turb. Marbore 2 @ 880 lb. t	405
Soc. Industrielle pour l'Aeronautique	S. 200	Minijet	Trainer	2	0	24 2	16 9	5 6	103	1 060	1 895	1 Turb. Palas @ 350 lb. t	240
	S. 300		Trainer	2	0	24 2	22 1	8 5	108	1 156	1 935	1 Turb. Palas @ 350 lb. t	233
Societe Payen-Aviation	PA-49		Exp.	1	0	1? 0	16 ?	7 2	121	1 005	1 ?30	1 Turb. Palas @ 330 lb. t	310
Soc. des Avions & Moteurs Henri Potez	Potez 75		Attack	2	6	42 ?	32 0	8 6	247	3 900	5 280	1 Potez 8D32 @ 450 hp.	175
Soc. Nat. de Constructions Aeronautiques du Nord	NC-856A	Norvigie	Obs.	3	0	39 5	26 0	7 2	182	1 455	2 550	1 Snecma Regnier 4L04 @ 14? hp.	120
	Nord 2501	Noratlas	Trans.	3	42	106 5	72 0	19 1	1 085	28 600	48 400	2 Snecma Hercules @ 2 040 hp	273
	Nord 3200		Trainer	2	0	32 5	26 3	10 0		2 050	2 700	1 Salm. 8 AS @ 260 hp	175

Abbreviations

Al—Alvis
A S—Armstrong Siddeley
ASW—Anti-submarine warfare
AW—All-weather
Bl—Blackburn
Br—Bristol
Con—Continental
DH—de Havilland
eshp—Equivalent shaft horsepower
hp—Horsepower
lb t—Pounds thrust
Lyc—Lycoming
M>1—Supersonic
P&W—Pratt & Whitney
R-R—Rolls-Royce
Snm—Snecma Flygmotor
Wr—Wright

Leading Foreign Aircraft Military and Civil

Manufacturer and address	Model designation	Aircraft name	Primary mission	Max. no. of crew	Max. no. of passengers	Overall wingspan ft.	Overall length ft.	Maximum height ft.	Wing gross area, sq. ft.	Weight empty lb.	Gross weight lb.	Number, make, model and max rating of powerplants	Max. speed mph.
Soc. Nat. de Constructions Aeronautiques du Sud-Est	S E 210	Caravelle	Trans.	5	70	112 5	103 1	29 3	1,571	41 800	84 180	2 RS Avon R A 16 @ 9 000 lb. t.	
	S.E. 5000	Baroudeur	Fighter	1	0	32 0	44 7	11 7		10 200	11 615	1 Snecma Atar 101D @ 6 160 lb. t.	650
		Aquilon	Fighter	2	0	41 8	36 8	8 0		10 790	14 450	1 DH Ghost @ 4,850 lb t	585
Soc. Nat. de Constructions Aeronautiques du Sud-Ouest	S.O 4050	Vautour	Attack	2	0							2 Snecma Atar 101 @ 0,000 lb. t.	M>1
	S.O 9000	Trident	Fighter	1	0							3 SEPR rockets	M>1
GREAT BRITAIN													
Sir W. G. Armstrong-Whitworth Aircraft, Ltd.		Sea Hawk F.B. 3	Fighter	1	0	39 0	40 0					1 R R Nene	
		Meteor N.F. 14	AW Ftr	2	0	43 0	49 9					2 R R Derwent	
Auster Aircraft, Ltd.	J5B	Autocar	Pers.	1	3	36 0	23 2	6 0	185		2 400	1 DH Gipsy Major 1 @ 130 hp	117
	J5F	Aiglet	Trainer	1	3	32 0	23 2	6 0	184	1 380	2 200	1 DH Gipsy Major 1 @ 130 hp	125
	A.O.P Mk. 6		Obs.	2	0	36 0	23 8	8 0	185	1 413	2 105	1 DH Gipsy Major 7 @ 145 hp.	123
	A.O.P Mk. 9		Obs.	3	0	36 5	23 8	8 9	193	1 550	2 190	1 Bl Bombardier @ 180 hp.	127
Aviation Traders, Ltd	—	Accountant	Trans.	2	30						24,000	2 R R Dart 6	290
Blackburn & General Aircraft, Ltd.	G.A.L. 60	Beverley	Trans.	4		162 0	99 5	38 9	2 916	82 100	135,000	4 Bris. Centaurus @ 2,850 hp.	238
Bristol Aeroplane Co., Ltd	170 Mk 31M	Freighter	Trans.	2	0	108 0	68 3	21 6	1,487	27 110	44,000	2 Bris. Hercules 734 @ 1 980 hp.	163
	175	Britannia 100	Trans.	6	90	142 3	114 0	36 8	2 055	80 000	150,000	4 Bris. Proteus 705 @ 3,780 eshp	
		Britannia 300	Trans.	9	99	142 3	124 3	36 8	2 055	84 000	155,000	4 Bris. Proteus 755 @ 4 150 eshp.	
		Britannia 300 LR	Trans.	9	93	142 3	124 3	36 8	2 055	83 500	[illegible]	4 Bris. Proteus 755 @ 4 150 eshp	
Boulton Paul Aircraft, Ltd	P 108A	Balliol T 2	Trainer	2	0	39 4	35 1	12 6	250	6 730	8 410	1 R-R Merlin 35 @ 1 280 hp	292
	P 111A		Exp.	1	0	33 5	26 1	12 8				1 R R Nene	
De Havilland Aircraft Co., Ltd		Vampire Trainer	Trainer	2	0	38 0	34 5	6 5	261		12 920	1 DH Goblin 35 @ 3,500 lb t	549
		Chipmunk Mk 20	Trainer	2	0	34 3	25 4	7 0	173	1 425	2 100	1 DH Gipsy Major 8 @ 145 hp.	134
		Venom Mk. 3	AW Ftr	2	0	41 8	36 8	6 5				1 DH Ghost 104	
		Venom FB Mk. 4	Fighter	1	0	41 8	36 8	6 8				1 DH Ghost 104	
		Sea Venom Mk. 21	AW Ftr	2	0	42 8	36 8	6 5				1 DH Ghost 104	
	D H 110		Inter	2	0	51 0	52 1	10 1				2 R-R Avon	
		Dove 6	Trans.	2	8	57 0	39 3	13 4	335	6 040	8 800	2 DH Gipsy Queen 70 @ 380 hp	209
	D H 106	Comet 2	Trans	6	44	115 0	96 0	28 5	2,015		120,000	4 R R Avon @ 7 350 lb. t.	
	D.H 106	Comet 3	Trans	6	58	115 0	111 6	28 5	2 121		150 000	4 R-R Avon @ 10 000 lb. t.	
		Heron 2	Trans	2	17	71 6	48 6	16 0	499	8 010	13 000	4 DH Gipsy Queen 30 @ 250 hp	181
English Electric Co., Ltd.		Canberra B 8	Bomber	2	0	64 0	65 6	15 6				2 R R Avon	
	P 1		Fighter	1	0							2 A-S Sapphire	
Fairey Aviation Co., Ltd		Gannet A.S. Mk. 1	ASW	3	0	54 4	43 0	13 8				1 A-S Double Mamba 100 @ 2 950 eshp.	
		Delta	Res.	1	0							1 R R Avon	
Folland Aircraft, Ltd		Midge		1	0	20 8	28 8				4 500	1 A-S Viper 101 @ 1 640 lb. t.	
		Gnat	Inter	1	0	22 0	30 0	8 0	137	3 794	5 000	1 Bris. Orpheus	
Gloster Aircraft Co., Ltd.		Meteor F.R. 9	Fighter	1	0	37 2	44 7	13 0	350	10 768	15 650	2 R-R Derwent 8 @ 3,500 lb. t.	585
		Meteor P.R 10	Photo		0	43 0	44 3					2 R-R Derwent 8 @ 3 500 lb. t	576
		Javelin F A W 1	AW Ftr	2	0	52 0	57 0	16 0	920		27 000	2 A-S Sapphire	
Handley Page, Ltd.	H.P 80	Victor B 1	Bomber		0	110 0	114 0	28 8				4 A-S Sapphire	
	H.P.R. 3	Herald	Trans.	4		95 0	70 3	22 5	882	22 320	24 000	4 Alvis Leonides Major @ 870 hp.	240
Hawker Aircraft, Ltd.	P 1067	Hunter F 1	Fighter	1	0	33 8	45 0					1 R R Avon 7 @ 7 500 lb. t	
	P 1067	Hunter F 2	Fighter	1	0	33 8	45 0					1 A-S Sapphire	

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Manufacturer and address	Model designation	Aircraft name	Primary mission	Max. no. of crew	Max. no. of passengers	Overall wingspan ft.	Overall length ft.	Maximum height ft.	Wing gross area, sq. ft.	Weight empty, lb	Gross weight lb.	Number, make, model and max. rating of powerplants	Max. speed, mph.
Hunting Percival Aircraft, Ltd		Pembroke	Multi	2	10	84 5	1d 6	16 6	400		13 000	2 Alvis Leonides @ 550 hp.	220
		Provost T Mk 1	Trainer	2	0	35 2	28 8	12 2	214		4 110	1 Alvis Leonides @ 550 hp.	201
		Jet Provost T Mk 1	Trainer	2	0	35 6	31 9	12 8	214		5 750	1 A-S Viper @ 1 750 lbf	324
A. V. Roe & Co., Ltd.	696	Shackleton M.R. 2	ASW		0	120 0	87 3					4 R R Griffon	
	698	Vulcan B. 1	Bomber			99 0	97 0					4 Bl. Olympus	
Scottish Aviation, Ltd		Pioneer CC Mk. 1	Comm	1		49 8	34 3	10 3	390	1 010	5 800	1 Alvis Leonides 502 1 @ 540 hp	150
		Twin Pioneer	Trans.	1	16	76 0	45 1	13 8	670	9 075	13 900	2 Alvis Leonides 503 @ 540 hp.	180
Short Bros. & Harland, Ltd	S.B. 5		Res	1	0	30 5	45 6					3 R R Derwent	
	S.B. 1	Sherpa	Res	1	0	38 0	31 0	0 1				2 Turb @ 350 lb. t	
	S.B. 6	Seamew A.S. 1	ASW	3	0	65 0	41 0	15 5				1 A-S Mamba	
Vickers-Armstrongs Ltd.		Swift F Mk 1	Fighter	1	0	32 3	31 5	12 3				1 R R Avon RA7R @ 8 500 lb t	
		Valiant B Mk. 1	Bomber			111 3	108 3					4 R R Avon RA 11 @ 9 500 lb t	
	525		Fighter	2								2 R R Avon RA * @ 8 500 lb t	
	V 700	Viscount	Trans	3	59	93 3	81 2	28 8	993	35 681	58 500	4 R R Dart @ 1,520 eshp.	
	V 1000		Trans.		150	140 0	116 0	38 5				4 R R Tyneys	
	W 35	Wyvern S. 4	Strike	1	0	44 0	41 6	14 5	385	15 280	21 300	1 A-S Python 3 @ 4 110 eshp	
HOLLAND													
Royal Dutch Aircraft Factories (Fokker)	S. 11	Instructor	Trainer	2	0	36 1	27 0	7 0	199	1 785	2 425	1 Lyc. O-435-A @ 190 hp	120
	S. 13	1 operational Trainer	Trainer	2	0	53 11	34 0	13 0	405	9 225	12 750	2 P&W RJ-10 @ 600 hp.	220
	S. 14	Mach Trainer	Trainer	2	0	39 5	43 *	15 3	342	8 400	11 800	1 R R Derwent 8 @ 3 470 lb. t.	455
	S. 14 2	Mach Trainer	Trainer	2	0	39 5	43 1	15 3	342		12 450	1 R R Nene 2 @ 5 100 lb t	530
	F 27	Friendship	Transport	3	56	95 0	73 0	28 5	*51	20 410	34 200	2 R-R Dart @ 1 690 eshp	280
ITALY													
S. A. I. Ambrosini	S. 7	Supersette	Personal	2	0	28 8	28 8	8 2	138	2 165	3 060	1 Alfa Romeo 115 @ 230 hp.	178
	S. 4	Rondone	Personal	2	0	28 6	20 2	9 2	114	748	1 210	1 Walter Mikron 6 @ 65 hp.	110
Soc. Aero Caproni	F. 5		Trainer	2	0	25 8	21 8	8 0	107	1 102	1 650	1 Turbon 1 a Palas @ 330 lb t	242
Fiat Societa Aeritalia	G. 46-2B		Trainer	2	0	11 2	27 9	7 0	172	2 450	4 150	1 DH Gipsy Queen @ 245 hp	204
	G. 46 3B		Trainer	2	0	31 2	27 *	7 9	172	2 125	3 415	1 Alfa Romeo 115 @ 122 hp	101
	G. 46-4		Trainer	2	0	10 11	31 7	9 1	255	4 810	6 000	1 Alvis Leonides @ 870 hp	225
	G. 46 2		Trainer	2	0	1 0	30 11	9 0	255	4 810	6 000	1 P&W R1340 @ 600 hp.	236
	G. 59-1A		Trainer	1	0	38 0	31 1	12 1	277	6 180	7 930	1 R R Merlin @ 1 400 hp	380
	G. 59 4B		Trainer	2	0	38 0	31 1	12 1	277	6 282	8 405	1 R R Merlin @ 1 400 hp	380
	G. 80-3B		Trainer	2	0	36 1	41 9	11 3	271	9 260	12 540	1 DM Goblin 35 @ 3,500 lb. t.	535
	G. 82		Trainer	2	0	39 1	42 5	13 5	271	9 700	13 890	1 R-R Nene @ 5,000 lb. t.	605
Aeronautica Macchi	M.B. 308		Personal	2	0	32 8	21 4	7 1	148	915	1 433	1 Cun. C85 @ 85 hp	118
	M.B. 320		Personal	1	5	42 0	28 1	10 8	227	3 284	4 960	2 Cun. E185 @ 185 hp	200
	M.B. 323		Trainer	1	0	39 5	30 0	13 4	210	1 245	5 500	1 P&W R1340-S1H1 @ 600 hp	250
Nardi Soc. Aeronautiche	F.N. 333		Personal	1	3	32 7	23 0	8 8	145	1 025	2 050	1 Cun. C85 A @ 225 hp.	168
Piaggio & Co. S.p.A.	P. 136-L		Personal	4	4	44 4	36 4	11 5	263	3 990	5 730	2 Lyc. GO-435-C2 @ 200 hp	178
	P. 148		Trainer	2	0	36 5	27 *	7 0	203	1 834	2 645	1 Lyc. O-435-A @ 190 hp	118
	P. 149		Personal	1	3	35 8	28 1	9 8	203	2 400	3 468	1 Lyc. GO-435-C2 @ 260 hp	184
	P. 150		Trainer	2	0	43 5	30 3	9 2	271	4 277	5 940	1 P&W R1340-S3H1 @ 600 hp	236
SWEDEN													
Svenska Aeroplan A. B.	Saab-29	J-29	Fighter	1	0	38 1	33 2	12 3	255	8 489	13 360	1 Sven. RM-2 @ 5,000 lb. t	660
	Saab-32	A-32 Lansen	AW Fit	2	0	42 7	49 2	15 5			22 200	1 Sven. RM-5 @ 9 500 lb t	700
	Saab-90A-2	Scandia	Transport	3	40	51 9	39 6	14 3	922	21 930	35 270	2 P&W R1830-S1 @ 1 800 hp.	277
	Saab-91B	Safir	Trainer	3	0	31 3	26 0	7 2	143	1 580	2 315	1 Lyc. O-435 A @ 190 hp.	176
	Saab-91C	Safir	Personal	1	3	34 8	26 0	7 2	143	1 625	2 383	1 Lyc. H435-A @ 180 hp.	169
	Saab-210	Draken	Research	1	0							1 A-S Adder @ 1 050 lb t	

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Leading Foreign Gas Turbines

Manufacturer and address	Designation	Type	Stages of compression	Turbine stages	Combustion chambers	Max. rating	Specific fuel cons., lb./lb./hr. or lb./eshp. hr	Compression ratio	Overall envelope length in.	Overall envelope diameter in.	Dry weight, less tailpipe lb.	Remarks
AUSTRALIA												
Commonwealth Aircraft Corp. Pty., Ltd. *Port Melbourne*	Nene 2 VH	CFJ	1	1	8	5 000 lb. t.	1 00	4 0	104	50	1 910	
	Avon Mk. 1	AFJ	12	2	8	6 500 lb. t.	0 89	6 0	127	42	2,258	
CANADA												
Orenda Engines, Ltd *Malton, Ont*	Orenda 11	AFJ	10	2	8	7 000 lb. t.			121	48	2 405	
	Orenda 14	AFJ	10	2	8	7 275 lb t			121	48	2 425	
GREAT BRITAIN												
Armstrong Siddeley Motors, Ltd. *Parkside, Coventry*	Mamba ASM.3	AFP	10	2	6	1 475 eshp	0 80	5 4	58	20	780	
	Double Mamba ASMD 1	AFP	10	3	6	2 950 eshp	0 80	6 4	80	53	2 100	
	Python Mk. 3	AFP	14	2	11	4 110 eshp	0 80	6 4	120	54	3 450	
	Sapphire ASSa.1	AFJ	12	6		10 000 lb. t				35		
	Viper ASV.3	AFJ				1 640 lb t			46	23	468	
Bristol Aeroplane Co., Ltd. *Filton, Bristol*	Proteus 755	ACFP	12A 1C	4	3	4 100 eshp	0 48	7 2	113	40	3 000	
	Olympus Mk 101	AFJ				15 000 lb. t.	0 77		124	40	3 650	Made under license in U. S. by Wright as J67
	Orpheus	AFJ									850	Medium-power for lightweight fighters and trainers
	B.E.28	AFP		4		4 000 eshp.						Supercharged turboprop with constant TO power anywhere
De Havilland Engine Co., Ltd. *Edgware, Middlesex*	Gabin 30	CFJ	1	1	10	3 500 lb t	1 10	3 7	106	50	1 610	
	Ghost Mk. 103	CFJ	1	1	10	6 050 lb. t.	1 10	4 0	101	53	2 154	Latest version is Mk 104
	Gyron	AFJ										
D. Napier & Son, Ltd. *London W 3*	Eland E 141	AFP	10	2	6	3 000 eshp.	0 52	7 0	122	36	1 075	Production engines available from Jan 1956
	Oryx	AFJ	12	2	6	750 ghp	6 58		83	10	485	Gas generator for Hunting Percival P.74 helicopter
	Eland E.153	AFP	10	3	6	4 000 eshp.	0 56	7 0	122	36	1 510	
Rolls-Royce, Ltd. *Derby*	Dart Mk 506	CFP	2	3	7	1 540 eshp.	0 73	5 0	95	38	1 064	
	Dart Mk. 510	CFP	2	2	7	1 890 eshp	0 71	6 5	97	38	1 197	
	Derwent Mk. 8	CFJ	1	1	8	3 500 lb t	1 05	4 0	83	43	1 260	
	Nene 10	CFJ	1	1	9	5 100 lb t	1 06	4 0	103	50	1 620	
	Nene 101	CFJ	1	1	9	6 000 lb. t	1 05	4 0	78	50	1 618	
	Nene 102	CFJ	1	1	9	6 100 lb t	1 08	4 0	97	50		
	Avon 503 (R.A.25)	AFJ			8	7 000 lb. t.	0 81		103	42	2 440	
	Avon Mk. 521	AFJ			A	10 000 lb t	0 87		113	42	2 790	
	Avon R.A.7	AFJ			8	7 300 lb t	0 82		110	42	2 490	
	Avon R.A.7R	AFJ			8	9 500 lb t			120	42	2 485	
	Avon R.A.14	AFJ			A	9 500 lb t	0 84		113	46	2 860	
	Avon R.A.21	AFJ			8	8 000 lb t	0 83		110	42	2 520	
	Avon R.A.28	AFJ	—	—	A	10 000 lb. t	0 85		113	42	2 800	
	Soar Mk 101	AFJ			A	1 810 lb. t.	1 20		77	18	276	
	Conway R.Co.2	AFJ										
	Rtl 100	AFP	—	—		4,405 eshp			107	30	1 890	
FRANCE												
Societe d'Exploitation des Materiels Hispano-Suiza *Bois Colombes (Seine)*	Nene	CFJ	1	1	9	5 065 lb. t.	1 04	4 0	95	48	1 606	Built under Rolls-Royce license
	Tay T250	CFJ	1	1	9	6 890 lb t	1 06		109	50	2 022	Built under Rolls-Royce license
	Verdon R-460	CFJ	1	1		7 709 lb t.			101	46	2 015	Development of R-R Tay
Societe Rateau *La Courneuve (Seine)*	SRA-101	AFJ	10	2	12	8 300 lb. t.	0 85		138	44	2?88	
Societe Nationale d Etude et de Construction de Moteurs d'Aviation *Paris*	Atar 101D	AFJ	7	1	A	9 056 lb. t.	1 03		141	76	2 068	
	Villaum	AFJ				13 206 lb. t.					3 100	
Societe Turbomeca *Pau*	Artouste	CFP	1	1		280 eshp.	0 85		31	21	185	
	Marbore 2	CFJ	1	1		880 lb t	1 16	3 0	32	22	286	
	Palas	CFJ	1	1		352 lb t	1 22		42	10	132	
	Palouste	CFJ	1	1		528 lb t		3 6	40	38		Gas-generator

Abbreviations
A — annular
AFJ — axial-flow turbojet
AFP — axial-flow turboprop
CFJ — centrifugal-flow turbojet
CFP — centrifugal-flow turboprop
eshp. — equivalent shaft horsepower
ghp. — gas horsepower
lb t. — pounds of thrust

Leading Foreign Rotary-Wing Aircraft

Manufacturer and address	Designation	Name	Seats, incl. crew	Dimensions: Rotor diameter, ft.	Dimensions: Length blades unfolded, ft.	Dimensions: Max. height to rotor top, ft.	Weights: Weight empty, lb	Weights: Normal gross weight, lb	Powerplant: Number, manufacturer, designation and max. rating of powerplant	Performance: Fuel capacity, gal.	Performance: Maximum speed, mph	Performance: Initial rate of climb, fpm.	Performance: Hovering ceiling in ground effect, ft.	Performance: Service ceiling, ft.	Performance: Maximum still-air range, mi.	Remarks
GREAT BRITAIN																
Bristol Aeroplane Co., Ltd. *Filton, Bristol*	171 Mk. 4 173 Mk. 3	Sycamore	5 16	48 0 48 0	61 0 77 0	14 6 17 3	4 150 6 714	5 400 13 495	1 Al. Leonides 524 1 @ 520 hp. 2 Al. Leonides Major @ 1 740 hp.	78 290	120 153	1 000 2 000	8 400 11 000	15 500 16 000	370 348	Development for MoS military copter
Fairey Aviation Co., Ltd. *Hayes, Middlesex*		Rotodyne Jet Gyrodyne	44 4	90 0				33 000	1 Napier Eland @ 3,000 ehp. 1 Alvis Leonides @ 525 hp.						250	Two prototypes bought by MoS Rotor head is similar to Rotodyne
Hunting Percival Aircraft, Ltd. *Luton, Bedfordshire*	P 74		16				4 900	8 000	1 Napier Oryx @ 750 shp							
Saunders Roe, Ltd. *Osborne, E. Cowes, Isle of Wight*		Skeeter Mk. 5 Skeeter Mk. 6	2 2	32 0 32 0	31 1 31 1	7 5 7 3	1 870 1 890	2 100 2 200	1 Bl. Bombardier 702 @ 180 hp. 1 DH Gipsy Major 10 @ 180 hp.	34 34	95 101	880 940	3 800 4 200	11 300 11 900	265 260	
Westland Aircraft, Ltd. *Yeovil, Somerset*	W-S-51 W-S-55	Dragonfly	4–5 10–12	49 0 55 0	62 3	13 1	4 325 4 780	5 700 6 800	1 Al. Leonides @ 524 hp. 1 P&W R1340-40 @ 600 hp	70 160	111	780 880	9 000		250 420	Built under Sikorsky license Built under Sikorsky license
FRANCE																
Société Matra *Boulogne-sur-Seine*	M C 101	Cantinieau	2–3	25 3	22 0	7 5	882	1 325	1 Continental @ 155 hp.							
Société Nationale de Constructions Aeronautiques du Sud-Est *Paris*	S.E.3120	Alouette	2	38 2	34 6	9 6	1 050	2 750	1 Salmson 9NH @ 300 hp.	36	78	885				
Société Nationale de Constructions Aeronautiques du Sud-Ouest *Paris*	S.O.1110 S.O.1221 S.O.1310	Ariel 3 Djinn Farfadet	3 2 4	33 4 33 8 38 7	24 0 17 4	6 6	1 496 682	2 750 1 540	1 Turbomeca @ 275 ehp. 1 Turb. Palouste @ 825 ehp. 1 Turb. Artouste 2 @ 380 ehp.		102 82 190		5 900 3 280		186 310 240	

Abbreviations
Al — Alvis
Bl — Blackburn
DH — De Havilland
MoS — Ministry of Supply
P&W — Pratt & Whitney Aircraft
Turb — Turbomeca

On more than 34,000 J47 turbojets delivered . . .

6-POINT G-E SERVICE PROGRAM HELPS CUT JET OPERATING COSTS

Over 250 G-E jet representatives at 100 locations in the U.S. and overseas help engine users get peak jet performance—anywhere, anytime

G.E.'s six-point jet service program is set up to help G-E engine users reduce their operating costs and get top performance from G-E J47 and J73 engines. Over the past four years, this program has helped reduce maintenance time-cycles. It has added extra operating life to G-E engines in the field. It has helped cut users' manpower needs. The program includes these major benefits:

WORLD-WIDE COVERAGE—In the U.S. and 13 foreign countries, the six technical services shown below are available at military bases, overhaul stations, spare parts depots, special test locations and G-E repair, overhaul and modification shops.

HIGHLY-SKILLED G-E TECH REPS, key members of the team, are on 24-hour call at bases here and abroad, in Stateside G-E service shops and through 65 G-E district offices. As part of G-E's complete technical services, Company representatives have a library of technical publications and training aids. They also can supply engine users with training films, visual aids, parts catalogs and handbooks for pilots.

PUBLICATION GEA-6136, "Operation Service," describes the six-point program in detail. For a copy, contact a G-E Aircraft Specialist via your nearest G-E Apparatus Sales Office. Or write *Section 232-4, General Electric Company, Schenectady 5, N. Y.*

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GENERAL ELECTRIC

1. **JET ENGINE TROUBLE-SHOOTING.** To help minimize aircraft "ground-time," G-E tech reps are available throughout the Free World to help personnel discover, correct unusual engine difficulties.

2. **CLASSES IN THE FIELD.** Using standardized manuals and visual aids, G-E reps often conduct classes designed to give students a better understanding of jet operating and maintenance procedures.

3. **PARTS REPLACEMENT.** Tech reps often help determine amount of parts needed to support flight operations, make available tools and test equipment for field use.

4. **G-E REPAIR, OVERHAUL AND MODIFICATION SHOPS** provide complete maintenance service to customers. Shops are conveniently located to airframe manufacturers and USAF bases, thus help reduce users' costs.

5. **ENGINE SERVICE ANALYSIS.** Jet service reports gathered in the field are analyzed in IBM machines to give valuable information for parts replacement estimates, also for improvement of engine design for the Armed Forces.

6. **ENGINE TRAINING SCHOOL.** Advanced instruction in G-E engine operation and maintenance is given on request to military and civilian personnel at the Company's Cincinnati plant.

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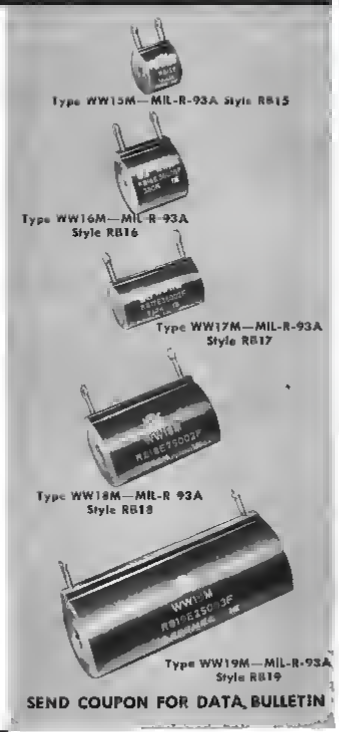
The presence of extreme climatic conditions, unusual ambient temperatures or salt water are offset by a new IRC encapsulating technique. This IRC development uses an epoxy resin compound for both the winding form and the seal. A special molding process avoids air pockets and assures even, complete distribution of the resin. Designed to operate at 125° C. and to meet the military requirements of salt water immersion, these units exceed MIL-R-93A specifications in 1%, 0.5%, 0.25% and 0.1% tolerances



Type WW15M—MIL-R-93A Style RB15

Type WW16M—MIL-R-93A Style RB16

Type WW17M—MIL-R-93A Style RB17

Type WW18M—MIL-R-93A Style RB18

Type WW19M—MIL-R-93A Style RB19

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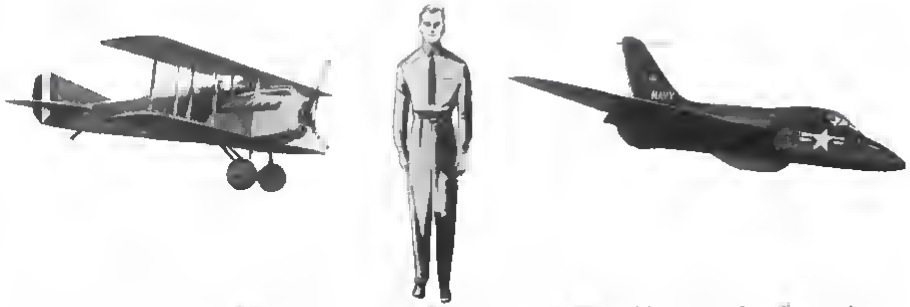
AVIONICS

No weapon system has any value unless it can be directed to accomplish a mission—defense against attack by enemy forces or destruction of enemy installations. Technology in the Age of Peril is advancing the performance of the systems far beyond the capacity of man's unaided sensory and physical faculties to control them accurately.

Avionics closes this gap between man and the machines. Improvements in performance are coming so rapidly that small improvements in the state of the art no longer are adequate. The avionics industry must search boldly for large technical improvements. Also, it must head off production bottlenecks by revolutionizing manufacturing processes.



AVIONICS FACES TOUGH JOB bridging gap between man's basically unchanged capabilities and his ever-more-demanding aircraft

Bold New Approaches Needed As . . .

Military Avionics Seeks Jackpot Payoffs

By Philip Klass

The airplane changes radically, and aerial warfare with it, but man remains the same.

The task of bridging this ever-widening gap between "Mach-busting" military aircraft and unchanging man is largely in the hands of the avionics industry and its engineers. To meet this challenge requires a bold approach.

The avionics industry cannot content itself merely with small improvements in the state of the art. It must strike out boldly and willingly to explore avenues which hold the potential of jackpot payoff: perhaps even technological breakthroughs.

The military services which sponsor and guide much of the avionics industry's activities have need also for boldness.

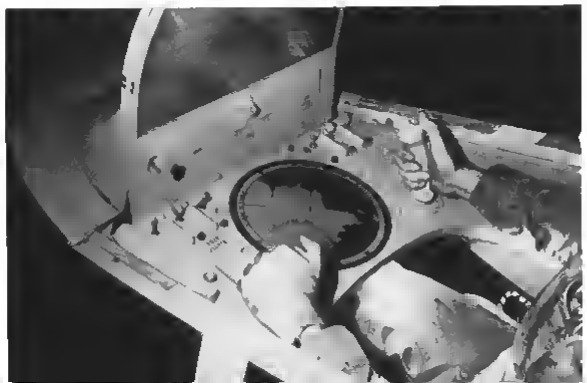
While in congressional circles there is need for understanding and realization that this bold approach frequently will produce no useful hardware, only knowledge which can buy future progress.

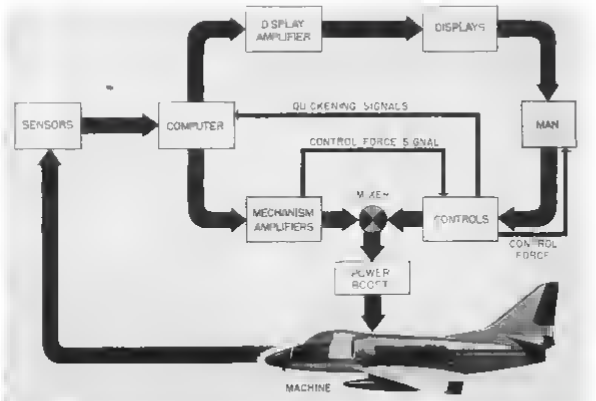
▶ **Look Beyond Today**—Capt. J. E. Sullivan, chief of BuAer's airborne equipment division, says "it is sometimes necessary in a fast moving science to make a sharp break with the past and deliberately take a new, forward looking approach not bound by the day to day happenings of the past. I believe this same principle should be extended to all aeronautical research and development efforts."

"If we had a longrange program in ... flight control systems, we would not be in the present chaotic condition ... where we add bob-weight to bob-weight, very critical hydraulic servos ...

IN PRESENT COCKPIT, pilot must integrate a variety of essential information from a mass of instruments while coping with problems of highspeed flight, but ...

IN FUTURE NAVY COCKPIT, only the information needed at any stage of the flight will be displayed pictorially on two flat TV tubes for the 'Mach-busting' pilot





NAVY OBJECTIVE FOR AIRCRAFT which will be designed in 1958 is integration of variety of instruments, computers and flight controls into one system.

to servos, bell cranks to bell cranks, with the result that we now have to operate and maintain very complex control systems," he claims.

Captain Sullivan's recommendations to industry are:

- **Stop gadgeteering.**
- **Systematize your thinking.**
- **Separate some people from everyday "fire drills" to let them take a longer-range look at the basic problems.**

▶**Excellent Example**—Sullivan's group and the Office of Naval Research have followed this advice in their revolutionary cockpit instrument display, which employs two of the radically new flat TV-type picture tubes developed by Wilkes Motors (AVIATION WEEK, Jan. 17, p. 17, Jan. 24, p. 19).

The new cockpit display slated to go into Navy fighters designed in 1958, is expected to slash pilot instrument training time by 75%, reduce pilot response time to new situations, and ease the transition from instrument to visual flight. The reason it is being system-engineered to conform to human capabilities instead of trying to shoehorn pilots into using existing piecemeal displays, many of them "unnatural."

In the new display information now shown on a multitude of individual panel instruments will be consolidated on two flat TV picture tubes:

- **Vertically mounted semi-circular tube, located directly in front of the pilot, will display altitude, speed, aircraft pitch and bank attitude and physical terrain features such as mountains.**
- **Horizontally mounted circular tube, located below the first and just inside the cockpit rim, will show broad physical features of the earth below, in radar mapping fashion, as well as needed navigation and traffic control information, distance to base, fuel remaining and similar information.**

The pilot will be able to select and display only that information which he needs at any stage of the flight. Eventually, the Navy hopes to build a stereoramic display which would cover the entire forward hemisphere of the cockpit.

Navy instrumentation engineers had long dreamed of the possibility of a simplified picture-type cockpit display. When they learned of Wilkes' new flat tube they moved quickly and boldly to convert their dreams into hardware.

▶**Bolder Than It Appears**—The boldness of the Navy program is greater even than it might appear at first glance. The new display is merely part of a larger Navy project to combine a variety of control functions, such as stability augmenters, autopilots, navigation computers, and instrument sensors into a single integrated system (see sketch above).

Objective is to eliminate weight, space and cost of duplicate sensors, computers, and controls, which have had a Topsy-like growth.

Wherever duplication is provided, it will be intentional, to provide standby redundancy for greater reliability.

The program, in its present form, was started two years ago. Douglas Aircraft's El Segundo division holds the responsibility for integrating the efforts of more than 25 contributing avionics firms, including Sperry Gyro, Bendix Aviation, Litton Industries, Kearfott, General Electric, Kelvin-Norden, Melpar, Wilkes Motors, Servo-Mechanisms and Minneapolis Honeywell.

▶**Another Good Example**—Hughes Air

J. F. McBrearty, chief structures engineer (left), discusses fatigue test program of integrally-stiffened wing lower surface structure of Super Constellation Model with E. H. Spaulding, structures division engineer and J. G. Leewolt, stress engineer. Lockheed's 500,000 lb. Force Fatigue Machine was used in test program.

Advanced structures facilities speed careers of Lockheed Engineers

Ralph Olive, research engineer, examines Super Constellation skin for signs of fatigue failure

Engineers in Lockheed's Structures Division are supported by unmatched research and testing facilities in their constant effort to increase strength while decreasing weight.

Among those facilities are the Lockheed-designed 500,000 Lb. Force Fatigue Machine, first of its size; Shimmy Tower, only one in private industry, and Drop Test Tower, largest in the nation.

Facilities such as these give engineers a major advantage in making technical advances — and thus advancing their careers. Moreover, the large number of projects always in motion at Lockheed mean continuing opportunity for promotion as well as job security.

Why Lockheed needs Engineers with Structures training:

1. **"Fail-Safe" Structures** — Lockheed has begun an extensive pioneering effort in the new concept of "fail-safe" structures. Studies are being applied to virtually all phases of Lockheed's diversified development program — already the largest in the company's history.

2. **New studies in:** Effect of high temperatures on structures; optimization of thin-wing designs and other aero elastic problems; new materials such as ultra high heat treat steel; panel instability at extremely high speeds.

Engineers interested in the "Fail-Safe" program and other studies are invited to write E. W. Des Lauriers, Dept. S-3-3.

Lockheed
AIRCRAFT CORPORATION
BURBANK, **California**

craft points to another notable example of the "bold approach" its pioneering efforts in the field of airborne digital computers.

During the past year security was lifted on the nation's first airborne digital computer—called Digitac—developed by HAC (Aviation Week May 10, 1954, p. 62).

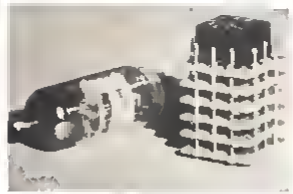
When Hughes began work on Digitac in 1948, the state of the art was such that a digital computer filled a large room, and its weight was measured in tons. Even the application of digital computers to "real time" problems such as bombing and fire control was relatively new.

Hughes engineers took a big look at the overall weapon system problem. Present day interceptors were then scheduled to carry individual analog computers to perform each of the specialized problems, i.e. fire control, navigation, automatic flight control. Each computer was used during only a small portion of the total mission. HAC engineers recognized that if a digital computer could be made small, light, and reliable, it could perform all of these functions at a considerable saving in size, cost, and weight.

Other potential advantages of digital computers included their ability to handle new or different problems without major internal change, greater inherent accuracy, and ease of manufacture without need for expensive machine tools and skilled workers required to build analog computers.

▶ **The Payoff**—Digitac itself, designed for use in tactical bombing and navigation, never went into production. However, it has more than returned its investment by spawning industrywide interest and development in the airborne digital computer field. Hughes itself is testing a much improved airborne digital computer, which reportedly is slated to go into production for use on the Convair F-102.

Today practically all of the major weapon system and computer manufacturers are developing airborne digital computers. The list is believed to include Sperry Gyro, International Business Machines Corp., Litton Industries, Librascope, Ramo-Wooldridge (under



IMPROVED TINKERTOY module, developed by ACF, soon will be available commercially from new automatic factory.

Westinghouse Air Arm division sponsorship), North American Aviation, Northrop Aircraft, Remington Rand, Radio Corp. of America, Bell Telephone Labs, Burroughs Corp., J. B. Rea Co., A. C. Spark Plug, Jacobs Instrument Co., and possibly others.

▶New Computer Techniques—Although HAC's leadership in this field is being challenged on many fronts, one of the more serious threats may come from Litton Industries (AVIATION WEEK Oct. 18, 1954, p. 62).

Litton bought a small firm headed by Floyd Steele, an oldtimer in the computer field, who has come up with some radically new ideas on computer design. These techniques reportedly make it possible to slash computer size, weight, complexity and cost by a factor of 10 to 20.

For example, Steele has constructed a 20 integrator digital differential analyzer which uses only 14 tubes and 180 diodes (plus power supply) and occupies a space of only one cubic foot (AVIATION WEEK Sept. 27, 1954, p. 70). This is a small fraction of the size and number of tubes that would be required if conventional techniques were used, Litton officials say.

▶Secrecy and Skepticism—Litton's secrecy on details of its new techniques has bred some skepticism in certain competing industry quarters. However, Litton successfully beat out 40 other bids to get the contract to develop the computer for Navy's new integrated instrument and flight control system previously described.

The company also reportedly has received a contract to produce mortar-tracking computers for the Marine Corps on the strength of an experimental unit which is far smaller, lighter, and cheaper than the computer it replaced. Wright Air Development Center labs also have shown considerable interest in the new Litton computer techniques.

▶Boldness in Automation—An excellent example of willingness to risk the "bold approach" was Navy's investment of $5 million in the Project Tinkertoy process and pilot automatic factory. When first unveiled more than a year ago, Tinkertoy created a big sensation in an industry which by its very nature had seemed to defy automation.

Industry observers universally agree that whether or not the Tinkertoy process itself catches on, the $5-million investment has more than paid off by stirring industry interest and action.

In the intervening year, automatic component placement machines have been designed by Admiral and United Shoe Machinery Co., primarily aimed at use in high production TV and radio lines. General Mills recently has revealed its new mechanized assembly machine, called Autofab, which Inter-

national Business Machines Corp. will use to build digital computers for air defense use. General Electric, Melpar, and others also are working on mechanized assembly.

▶ **ACF's Approach**—Despite keen interest by industry in automatic assembly and production, it has been slow to accept the Tinkertoy process. For one reason, there was no commercial large-scale source of Tinkertoy modules. (Output of the Navy's pilot plant has gone largely into sonobuoys as part of an evaluation program.) None of the equipment makers was willing to invest a million dollars or more into building its own Tinkertoy module plant, particularly since any single equipment producer would have trouble absorbing such a plant's full output.

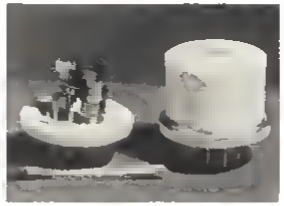
Recognizing this impasse, ACF Industries moved boldly. It hired the complete staff of National Bureau of Standards engineers which had developed Tinkertoy, set them up in Alexandria, Va., and provided nearly $2 million with which to improve the basic module and to set up an automatic factory.

Within the next 60 days, the avionics industry for the first time will be able to buy Tinkertoy modules (which ACF calls "Compacs") on a commercial basis, just as it now buys resistors and capacitors.

By this summer, ACF's Tinkertoy factory reportedly will be capable of turning out Tinkertoy modules at the rate of 400,000 units a month, building up to 1,000,000 a month by the end of this year. (AVIATION WEEK, Mar. 7, p. 50)

▶ **Tinkertoy Incentives**—In quantities of 50-100, the new ACF Compacs are expected to cost no more than the conventional resistors, capacitors and other components they replace. If experience bears out this expectation, the new ACF venture could create quite a stir both in electronic equipment and component industry circles. New and improved Tinkertoy resistors and capacitors developed by ACF are expected also to increase the number of applications for the Compacs.

As added incentive for BuAer con



RECENT IMPROVEMENTS in Sylvania stacked tube make it electrically equivalent or superior to conventional tubes.

tractors, Navy has issued directives encouraging avionic equipment suppliers to use Tinkertoy-type construction wherever feasible on potentially high-production equipments. BuAer's electronics division has begun to ask contractors to bid new equipment development and production contracts in two ways: conventional and Tinkertoy construction.

BuAer currently is weighing the possibility of contracting for this new type construction in four different equipments: sonobuoys, guidance equipment for a missile, a double-radar navigation device, and a special purpose receiver.

▶ **'Little Automatic Factory'**—General Electric recently released a few more details, including an artist's conception of its "little automatic factory," a mechanized component placement machine. It is particularly suited to accommodate frequent design changes and small production runs, making it attractive for avionics production.

The GE machine, developed under Signal Corps sponsorship, is slated for delivery this summer. It is designed to install a variety of conventional components in printed circuit boards using a single placement head. In this respect it differs from the United Shoe and Admiral approach, which employs a battery of machines, each of which installs only one or two conventional components. The GE machine reportedly can install components at the rate of 1,600/hour, then transport printed circuit boards automatically to an adjoining dip-solder bath.

Operating instructions come from punch cards, which give the machine its inherent versatility. Design changes involve only a change in punch card operating instructions.

▶ **Sylvania Stacked Tube**—Considering that tubes have changed very little in construction since they were first invented, the Navy BuShips-sponsored program at Sylvania Electric can be termed a "bold approach."

Sylvania abandoned the conventional "sheath type" construction (one electrode surrounding another) in favor of a stacked "layer cake type" construction (see photo p. 265). Flat tube electrodes are stacked on two pins separated and supported by ceramic spacers. The entire unit then is enclosed in a ceramic housing. (AVIATION WEEK June 28, 1954, p. 61)

The new ceramic stacked tube can be operated at temperatures of 300C to 400C, far beyond temperature limits of conventional tubes. It is more rugged, less affected by shock, vibration and thermal shock.

Another advantage is that the tube uses no mica spacers which, at high temperature, release moisture that attacks the conventional tube's cathode, cutting its life.

Sylvania tests indicate that all-im

portant transconductance (G_m) of its stacked tube drops off only 10% after 2,000 hours operation at room temperature compared to a drop of around 13% for conventional tubes. Stacked tubes operated for 7,000 hours at room temperature show a G_m drop of only 25%, Sylvania says.

▶ **Even Better Today**—Under continuing BuShips sponsorship, Sylvania has made improvements in the original stacked tube design revealed last summer. AVIATION WEEK has learned. These include:

• **Reduced weight.** Latest models weigh only 5 grams, 40% lighter than a glass tube of conventional construction, and approximately one-third the weight of early stacked tubes. Weight reduction is achieved by using smaller, thinner-walled ceramic shell.

• **Lower interelectrode capacitance.** By substituting ceramic stacking pins for previous metal ones, Sylvania says it has cut interelectrode capacitance to where it equals or is lower than that of conventional tubes.

Latest version of Sylvania's stacked tube, the SN-1724F, is electrically equivalent or superior to its conventional counterpart, the 6J6/6101, a company spokesman says.

Sylvania has recently announced development also of a new stacked version of a beam power tube, which currently is being readied for test.

▶ **Eimac Too**—Under USAF sponsorship, Eitel-McCullough, West Coast power tube maker, is developing all ceramic types of receiving tubes designed for mechanized production. The Eimac tube, with pill-box type construction and flexible connection leads instead of pins, is an even greater departure from conventional tube design.

Eimac is investigating a stacked building-block type of construction which would permit a large family of tube types to be made from a series of standard components.

For example, Eimac has designed a twin-triode, comparable to the 6SN7, which can be made into a twin-tetrode by adding two more grids during the assembly, or converted into a twin diode by leaving out the grids altogether.

▶ **Slicing Transformer Coils**—Sylvania also has had a hand in cracking another potential bottleneck—mechanization of transformer coil manufacture—under USAF sponsorship. The process developed by Sylvania consists of winding sheets of aluminum or copper foil and paper dielectric into rolls which resemble long paper capacitors, then slicing off thin wafers much as one would cut bologna (AVIATION WEEK June 14, 1954, p. 68).

The resulting "auto-wafers," as Sylvania calls them, are coated with a suit-

able dielectric and are then ready for stacking on a suitable transformer core. Individual wafers are interconnected by means of small metal tabs inserted during the initial winding process.

In addition to opening the way to mechanized production of transformers, the new process results in more compact transformer construction (because the conductors are essentially rectangular), as well as an appreciable saving in labor and material costs.

► **Once Bitten, Some Shy**—When transistors first were announced nearly seven years ago, their small size, lower power consumption and heat dissipation, and promise of long life seemed to be the answer to the avionics engineer's dream. However, as a result of early unreliability problems, many of them stemming from the lack of hermetic sealing, a number of engineers and companies soured on the devices. For this reason many firms today are still sitting back, waiting for transistors to come of age.

Not so with many others. It was five years ago, shortly after transistors made their first big splash, that Eclipse Pioneer (division of Bendix Aviation) took the bold step of trying to apply them to a missile flight control system. As a result of this pioneering effort, Eclipse Pioneer was in a position to propose a transistorized automatic flight control system when Convair was looking for such a system for its new B-58.

► **B-58 Payoff**—Convair knew that cooling of avionic equipment in its supersonic bomber would be a major problem. The prospect of a transistorized autoflight control system with little heat dissipation was too appealing to pass up, and E-P walked off with the contract in the face of stiff competition.

Today E-P is flight testing a tubeless autopilot, using transistors and mag amplifiers, on a company owned B-25, and Wright Air Development Center is getting ready to test a similar system on an F-94C. Transistor reliability has been no problem, a company spokesman says.

► **Other Transistor Pioneers**—A limited number of other companies showed a willingness to wade into transistorization, with the result that they now have a jump on competition. For instance, Bendix Pacific has transistorized several of its telemetering oscillators, reportedly with good results and reliability.

Minneapolis-Honeywell, although not a tube manufacturer, saw sufficient potential in transistors that it took a license from Western Electric in order to develop and produce power transistors needed for use in its servo systems. MH recently disclosed a new (P-21) germanium junction transistor, capable of handling 5 amp.

By applying transistors, including one

of its own power types to a capacitance fuel gage system. M-H cut system weight by nearly half, eliminated the need for a separate amplifier, and improved accuracy. Transistor reliability? No problem, M-H spokesmen say.

▶ **Transistors Better Than Ever**—Within the past six months, there has been a noticeable improvement in transistor reliability, a qualified Bell Labs spokesman has told AVIATION WEEK. This stems from wide use of hermetic enclosures, improved fabrication techniques, and more experience in transistor circuit design.

Like electron tubes, transistor reliability depends in no small part upon how the device is applied in a circuit and how close to rated limits it is operated. This is added incentive for an avionics firm to wade in and get transistor application know how first hand.

▶ **Other Encouraging News**—Texas Instruments removed one serious obstacle to the use of transistors in airborne avionics equipment which must operate at high ambient temperatures, when it revealed last spring that it could supply production quantities of three types of junction silicon units capable of operating at 100-150C. The company, which beat all of the "big name" transistor producers to the punch, currently is producing silicon transistors at the rate of about 1,000/day.

A company spokesman also revealed to AVIATION WEEK that Texas Instruments has built experimental silicon transistors with alpha cut-off frequencies as high as 20 mc. By the end of this year, the company hopes to be making silicon units rated at 10 watts with alpha cut-off frequencies as high as 100 mc.

▶ **UHF Transistor**—Possibly the most significant transistor development revealed during the past year was Bell Labs new "intrinsic barrier" transistor. The unit has been oscillated at frequencies as high as 465 mc., and theoretically might reach 3,000 mc., opening up entirely new uses for transistors in the UHF and possibly microwave region.

If a conventional p-n-p (positive-negative-positive) junction transistor is viewed as a "sandwich" of impure germanium between two metallic pellets, the new intrinsic barrier unit is a "club sandwich" with an added layer of pure (intrinsic) germanium between the impure germanium base and the metallic collector. The new device is referred to as a p-n-i-p transistor.

By all reports, the Bell development has spurred considerable interest and activity in semiconductor manufacturers' research labs around the country. It is logical to expect, therefore that the coming year will see several firms

announcing new intrinsic barrier transistors. The technique appears to be equally applicable to silicon transistors.

▶ **Adversity Into Advantage**—The transient reverse current that flows momentarily in a semiconductor diode has long been an undesirable characteristic in most applications. Recently, the National Bureau of Standards has come up with a novel way of exploiting this characteristic which enables the simple diode to serve as a pulse amplifier, opening up a whole new field of diode applications (AVIATION WEEK Nov. 22, 1954, p. 53).

The new "diode amplifier" holds promise of eliminating many of the electron tubes now used in airborne and ground-based digital computers, cutting equipment size and weight and increasing its reliability. The new technique can be applied to decade counters, pulse repeaters, various types of flip-flop circuits, or used as a wide band, flat-response amplifier. Power gains up to 10 per stage have been obtained.

▶ **Diode Amplifier Characteristics**—Like a magnetic or dielectric amplifier, the new diode amplifier requires an RF power supply whose frequency equals or exceeds that of the modulating (input) signal. Silicon diodes, with their faster transient recovery time, can be operated at much higher frequencies than germanium diodes. One experimental NBS current doubler type flip-flop using a silicon junction diode has been operated at a 25 mc. clock frequency and has exhibited start-stop times of about 50 millimicroseconds. With newer, improved silicon diodes, even higher frequency operation should be possible.

▶ **Other Semiconductors**—The considerable effort going into basic semiconductor research has produced several novel developments in recent months, and should produce even more in the coming year. Typical recent developments include:

• **Solar battery.** Bell Labs increased the efficiency of its solar battery to 8%, a third higher than its original model and 10-15 times greater than that of a conventional photo cell. A square yard of solar cell can develop 80 watts when exposed to full sunlight.

• **Light amplifier.** General Electric announced in December that it had developed the long sought true light amplifier. By applying a voltage between parallel electrodes of its new light cell GE says it can obtain a 10-fold amplification of light impinging upon the cell. The amount of amplification is proportional to the applied voltage. Key to the new device is a GE-developed transparent phosphor film which can sustain high electric fields without dielectric breakdown. (The GE transparent phosphor film also is used in the

new Willys flat tube to enable pilot to look through it during contact flight.)

Close on the heels of the GE announcement, Radio Corporation of America announced that it too had developed a light amplifier. Neither firm made mention of a solid state image intensifier, with amplifications of four, described by a Capehart-Farnsworth scientist in a paper which appeared four months earlier in "Electrical Communication," International Telephone & Telegraph Corp.'s technical journal.

The new light amplifier cells could find important military use in bright tube radar displays.

▶**Bold Approaches Needed**—There are many pressing problems arising from supersonic nuclear warfare which are crying for bold attempts at solution. For instance, the range of present interceptor radars may be adequate for 700 mph. interceptors attacking 500 mph. bombers. But if the interceptor of the future is flying at 1,000 mph. and the bomber at 800 mph., giving a 50% faster closing speed, then a radar with at least 50% greater range may be required.

Unfortunately increased radar range, in present systems, costs dearly. It involves either large increases in radiated power, or a larger antenna. Based on present designs, a larger antenna dish appears out of the question for needle-profile interceptors.

Some suggest that perhaps we need to take a step back and re-examine the whole radar early detection field, taking another look at techniques abandoned some years ago in the light of present day knowhow. In at least one instance, a small newcomer in this field beat out two large old-line firms for a very important contract by proposing to do just this.

▶**Penalties for Conservatism**—In the fast moving avionics field, a company that "plays it safe" by sitting tight usually finds later that it has lost position.

For instance, a BuAer spokesman cites an old line avionics firm which currently has no Navy interceptor fire control business, but which "could have had $25-million worth on its books today if it had moved boldly a few years ago."

At that time, BuAer had only one other fire control supplier; today it has many.

▶**Say It With Cash**—Sometimes a company needs the confidence to take a bold approach with its own funds. Several years ago, Lear concluded that it might achieve substantial cost reduction in gyro manufacture by substituting fabricated parts for precision castings which require expensive machining.

Using its own funds, Lear started work on a modest scale. Recently when Navy called for bids on a low-drift (MA-1) directional gyro which will become a fleetwide standard, Lear was ready.

Quoting its new fabricated gyro design, Lear underbid a lot of stiff competition and got a contract, sharing the procurement with GE.

Barry Controls, Inc., showed the same sort of willingness to risk its own funds on the development of a new all-position vibration isolator which the company believed met the industry's needs even though it did not meet existing MIL specs.

The Lab For Electronics' SPAR and the Gilfillan Quadradar, sometimes termed "poor man's GCA," show similar boldness in privately financed developments for an anticipated market.

Both sets are essentially small, low-cost, transportable versions of larger radars which both firms had built for the military. They are aimed at use by small civil airports and by military tactical aviation groups where transportability is an important consideration.

▶**To Keep Abreast**—If man is to keep abreast of fast-changing airplanes and warfare the avionics industry must be willing to explore the bold approach, knowledgeable observers insist.

Avionics firms that want to keep abreast of competition in this fast-moving field have even more incentive to risk the bold approach, they say.

Vortac Nav-Aid Battle Poses Question . . .

Can 1947 Concepts Meet 1955 Needs?

The current Vortac snafu underscores the fact that in the present Age of Peril, when the continental U. S. could become a nuclear battleground at any moment, the line of demarcation between "tactical" military and civil aviation nav-aid systems can no longer be firmly drawn.

The situation provides an expensive lesson in what happens when military and civil aviation agencies and groups fail to grasp this fact soon enough and proceed independently to develop and implement incompatible systems. It also demonstrates the difficulty of resolving such incompatibility after both parties are almost irrevocably committed to their respective systems.

In marked contrast, the success to date of the radar transponder beacon program, despite many obstacles, shows that when all parties recognize this new frame of reference, they demonstrate a willingness to compromise early in a program, making it possible to make a workable Common System approach. (AVIATION WEEK Feb. 14, p. 70).

The growing investment which civil aviation is making in avionics equipment, particularly the airlines as shown in chart at right, emphasizes the need for a workable, widely accepted Common System approach. Otherwise implementation of badly needed new avionic aids will lag for fear of premature obsolescence.

▶ **Indecisive Decision**—After more than a year of investigation and deliberation, the Air Navigation Development Board's attempt to resolve the Vortac controversy has produced a decision which raises more questions than it resolves.

The ANDB decision possibly was the wisest that could be made under the difficult conditions and limitations surrounding the problem, despite bitter criticism from some private aviation circles. By refusing fully to accept the majority recommendation made by its Vortac committee and by calling for further investigation before making an iron-clad decision, ANDB showed an open mind, observers generally agree.

▶ **The Next Move**—Here is the action which ANDB decided to take:

• **Complete Tacan development**, to improve present reliability and clear the way for its possible adoption as the Common System short-range nav-aid.

• **Continue VOR** as a Common System nav-aid at least until 1965.

• **Limit civil DME** to "experimental purposes" with no guarantee of service beyond June 30, 1955. (This is to assure that DME frequencies will be available to Tacan, if the latter is adopted.)

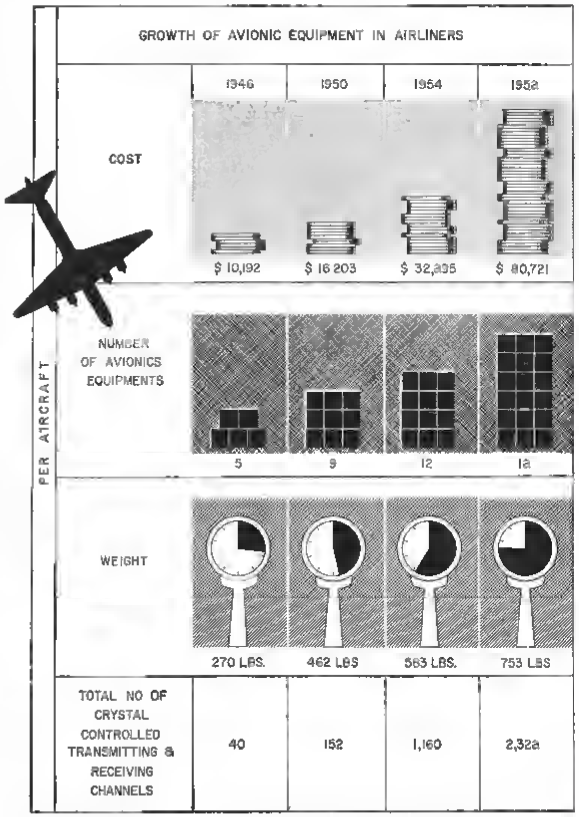
• **Authorize military** to implement Tacan to meet their minimum interim requirements on a basis which will be non-interfering with channels now assigned to civil DME and the Common System radar transponder beacon.

• **Develop UHF omnirange**, a continuous-wave system operating in the 1,365-to-1,660-mc. band, which could be used with present civil DME to provide rho-theta (range-azimuth) services in the event that Tacan proves unacceptable or inadequate.

Before Tacan can be accepted as a Common System nav-aid, "there are still substantial uncertainties which should be explored and resolved," ANDB says. These include:

• **Are there enough** interference-free channels available to permit Tacan's use for the Common System? This involves a careful study of civil and military airways ground station locations, traffic control facilities, and possible interference with other equipments operating in the same frequency band.

• **What is the relationship** between the



AIRLINER AVIONICS, as measured in dollars, equipments, weight, and number of radio channels, is expected to increase sharply by 1958, says Air Transport Assn.

Common System short-range nav-aid and the electronic ground environment being developed for our air defense system?

• **What will be the international implications** of a move to standardize on Tacan? VOR/DME now are an international standard adopted by the International Civil Aviation Organization after a long uphill battle

▶ **Who Gets Hurt**—Principal opposition to the adoption of Tacan as a future Common System nav-aid comes from the Civil Aeronautics Administration, Aircraft Owners and Pilots Assn., and National Business Assn. CAA, AOPA, and NBAA representatives on the Vortac committee each wrote their own dissenting minority reports. Air Force, Navy, Army, and Air Transport Assn. lined up pro-Tacan.

Based on these dissenting reports, it appears that adoption of Tacan at the expense of civil DME will adversely affect

• Private fliers by "prematurely" obsoleting VOR receivers and forcing users to purchase a more expensive equivalent Tacan receiver.

Although the basic conflict is between DME and Tacan, AOPA says it is "firmly convinced that (adoption of Tacan) . . . will immediately and automatically spell the end of not only DME but VOR as well." AOPA believes that "VOR would immediately become the secondary system in the eyes of Congress and the Bureau of the Budget, and that every effort would immediately turn to tapering off VOR . . . precisely the fate that has befallen the L/MF four-course radio ranges today."

• Business-plane operators, who do much off-airway flying and therefore need a rho-theta system today, will suffer for lack of DME, NBAA believes. Another NBAA complaint is that Tacan, unlike present VOR receivers, has no ILS localizer capability. (The fact that this aspect of the problem was not mentioned by others suggests that possibly the military may have some classified ideas for using Tacan as a terminal area landing aid, but this is mere speculation.)

• Air carriers who contemplate operating jets in three-to-five years may suffer for lack of a combination VOR/DME system. It appears there will be a race against time to get suitable civil Tacan equipment ready, unless the airline jet timetable itself is delayed.

• Hazeltine and Narco, which developed civil DME airborne units and had started to market them (Hazeltine through Bendix Radio), unquestionably have been hit by the ANDB decision.

What effect the decision will have on current pressing civil traffic control problems hinges on speculative answers

to several questions: How many aircraft otherwise would have equipped themselves with DME and how soon? How useful is DME as a traffic control device? How soon can equivalent civil Tacans be made reliable and available?

From the standpoint of the taxpayer, the damage has already been done. When Department of Commerce's Robert B. Murray, Jr., wrote on Feb. 5 to Assistant Secretary of Defense Donald A. Quarles, throwing in the sponge in behalf of the CAA, he said:

"Every month's delay in resolving this conflict of systems was extremely expensive in dollars, time, national defense and the eventual resolution of the truly Common System. Any further delay now in facing up to the facts would just result in still more damage."

▶Bitter Recriminations—AOPA, in a memorandum released to the press, indicates it is not giving up the fight. "The position taken by the ANDB is not the final disposition of this controversy," it says. "AOPA, for example, has already advised a number of members of Congress of the whole affair, and a number of other civil groups have undertaken other efforts to save the tremendous investments in VOR/DME."

"This matter involves a total of nearly half a billion dollars (not including any of the tremendous investment by private industry and civil users already made in VOR and DME Common System equipment), and has reached this point solely because of secret activities by military representatives that AOPA feels were either improper, illegal, or both," the group claims.

NBAA shares AOPA's bitterness and feeling of betrayal. In its own minority report, NBAA accuses the military of "surreptitiously" developing Tacan "with the full knowledge that it was incompatible with the officially established Common System." AOPA claims that the position of military members on the Vortac committee was that Tacan was "firmly and irretrievably committed for military adoption, and on a tremendous and costly scale," that civil aviation had best "get on the band wagon."

In view of these bitter recriminations it is well to attempt to re-examine the original basis of the Common System and the current hassle.

▶No Air Defense in 1947—Shortly after World War II ended, many bold new schemes were proposed as the future U. S. traffic control and navigation system. Each had its own camp of supporters. Congress indicated that it would finance only a single system, and that only if all airspace users could agree on a suitable one.

Thus, in 1947 when the Radio Technical Commission for Aeronautics as-

● **AVIONICS**

sembled a group of experts for its Special Committee 31 to blueprint the Common System, economy was the major motivation for a single civil-military system for domestic use.

Russia was still viewed in many quarters as a former ally, if a somewhat obstreperous one. The Reds had not yet exploded a nuclear bomb and appeared to have no longrange bombers capable of delivering one. In this context, it would seem illogical for SC-31 planners to blueprint a Common System primarily around air defense needs, instead of giving priority to the needs of the then mushrooming civil aviation, both air carrier and private.

So SC-31 planners blueprinted a system designed for a peaceful world in which military aircraft would be just one of many types of users. The big obstacle for SC-31 was bridging the gap between the needs of private fliers and all other users, not between civil and military aviation.

▶**Common System for Survival**—Today we live in a far different world—one which offers a far more impelling incentive than economy for a single Common System. That incentive is continental air defense and capability of global military air operations. In event of a hot war, a large percentage of our military aircraft will operate over the continental U.S., instead of from foreign shores as in the past.

Thus military "tactical" nav-aids are no longer purely a military matter and outside the scope of Common System planning. While this appears obvious to nearly everyone today, it was not so obvious to all military and civil agencies concerned with Tacan and DME a few years back.

▶**How Tacan Started**—When the Navy began its Tacan development in 1948-49, it was seeking a combination rho-theta system capable of providing accurate bearing and distance information from an aircraft carrier. It also wanted a system with more "security." Civil VOR lacked the required accuracy and could not be sited successfully from carriers. The Navy believed. Sometime later, the Air Force and Army adopted Tacan as a "Military Common System."

If Tacan's use had been limited to Navy carriers and a few shore stations, as originally planned, there might have been no Vortac problem today. But with Air Force adoption, and the plans for continental air defense which followed Russian atomic explosions, the need for a domestic Tacan network was born.

If this makes USAF appear as the culprit for adoption of Tacan instead of civil VOR/DME, it should be pointed out that Tacan was expected to provide greater accuracy for vectoring

interceptors and more security from enemy jamming. There undoubtedly were other factors, such as interservice and intraservice standardization and flexibility.

Still, the worst consequence of all these events might have been merely the cost of duplicate military and civil nav-aid systems, except for the unfortunate fact that Tacan and civil DME, both pulse-type systems operating in the 1,000-mc band, interfere with one another. The interference problem was aggravated when the decision was made to operate the Common System transponder beacons in the same 1,000 mc band.

▶**Two Tightrope Walkers**—Like two men walking toward each other on a tightrope, each pretending the other one isn't there, CAA and Navy continued their programs. Since the Tacan program was under security wraps, CAA can argue it did not know what was afoot and that it was adhering to the Common System plan laid down by RTCA's Special Committee 40.

The military could justify their original Tacan development by pointing to tactical exigencies which never were envisioned at the time of SC 31 and SC 40. The military too can find support in the original SC-31 report, because Tacan resembles the "ultimate" Common System nav-aid which SC-31 expected would replace the "interim" VOR-DME around 1962.

And in answer to private flyers' cry of "betrayal," the military could point out that VOR is now guaranteed an existence at least three years longer than originally planned by SC 31.

To this, CAA could reply that SC-31 expected any "ultimate" nav-aid would be compatible with the "interim" VOR DME, to permit orderly transition from one to the other. To which, the military might answer that there never would have been a Tacan-DME conflict if the latter had not been designed to use pulse multiplexing instead of clear channels.

▶**When Tightrope Walkers Meet**—About two years ago, the two tightrope walkers first acknowledged that there was someone else on the same rope. CAA and the military sat down to try to resolve their differences, but without success. Following this impasse, both raced ahead with their respective programs, a move which each figured would strengthen its bargaining position.

For this, both might be criticized justifiably. A logical agency to resolve the problem might have been the ANDB, except that it then lacked the power and authority to make such decisions stick, because the military pulled out its support after Korea.

▶**Hot One to ANDB**—Approximately a

year ago, ANDB was reconstituted with full military and civil support and was handed the Tacan controversy as its first assignment.

By this time, CAA had already invested more than $20 million in some 450 ground DME stations. The military had invested several hundred million dollars in the development and production of ground and airborne Tacan equipment.

Recognizing that it had been handed a hot potato, which affected many civil and military users, ANDB formed its seven-man Advisory Committee No. 1, popularly referred to as the Vortac committee.

To investigate and evaluate technical claims and counterclaims, the committee hired three able technical consultants: R. C. Newhouse of Bell Telephone Labs, H. R. Shafter, president of Airborne Instruments Lab, and J. B. Wiesner, director of MIT's electronics research lab.

▶ **Areas of Agreement**—According to the Vortac committee's report of Feb. 8, 1955, all seven members accepted the following findings of the consultants:

- **Coexistence.** A fully implemented Tacan and civil DME is not feasible because of interference between Tacan, DME and transponder beacons. Coexistence would be feasible only if Tacan were limited to partial implementation.
- **Siting.** VOR ground station siting is more critical than that for Tacan, requiring flat terrain cleared of all obstructions within a 1,000-ft. radius. This reportedly, is a serious obstacle to its military use. Tacan can get around such siting difficulties by elevating its antenna, not so with VOR.
- **Accuracy.** The distance measuring accuracies of both systems are roughly the same, and meet both civil and military needs. However, Tacan bearing accuracy reportedly runs better than 1 degree, compared to 3 degrees for VOR under good siting conditions. (Even better Tacan bearing accuracy may be obtainable with further equipment refinements.) VOR accuracy meets civil needs but not stated military needs.
- **Reliability.** Tacan is unreliable in its present form and will require extensive re-engineering of both ground and airborne units to meet civil aviation standards. By contrast, both ground and airborne VOR equipments have proven highly reliable in operational use and civil DME appears to be quite reliable, although operational experience is limited.

AOPA claims that Tacan is so unreliable that the committee's consultants had to spend considerable money during their investigations to bring the basic Tacan system to a point where they could measure its perform-

nce. Military spokesman tell AVIATION WEEK that tubes are a major cause of Tacan unreliability, responsible for two-thirds of the failures. Navy has already launched a program to improve Tacan reliability, including a complete back-up program at Collins Radio.

• **Size and Weight.** There is no significant difference between the size and weight of a bearing distance Tacan airborne unit and a VOR and DME receiver combined. Ground equipment is comparable except for a large counterpoise required by VOR.

However, from limited Tacan details released, it appears that a bearing only Tacan set will be considerably more complex and costly than present VOR sets, and the same applies to a lesser degree to a distance only Tacan versus present DME. AOPA cites a Collins estimate that a distance only Tacan might cost 60% more than DME. However, the addition of the second function reportedly adds little extra cost or complexity.

• **Co-Location.** Where military and civil airways coincide, CAA says that Tacan and VOR-DME ground stations must be located within 1,000 ft. of each other for traffic control purposes. Mounting antennas for the two systems on a single tower (co-axial, co-location) would impose structural problems and involve substantial development and testing to ensure that VOR accuracy was not affected, the consultants said.

If located on separate towers within a 1,000-ft. radius, VOR accuracy might still suffer. In both cases there would be DME-Tacan interference.

• **Communications.** Tacan does not now provide either voice station identification or voice communications, both possible with VOR. Voice identification could be added by modifying Tacan equipment—Tacan reportedly has the capability of incorporating data link, by which information and automatic control could be transmitted from ground to individual aircraft.

▶ **And Sharp Disagreement.**—Working from these, and other findings of the consultants which still remain classified, the Vortac committee split sharply in its conclusions and recommendations.

When the committee was unable to reach unanimous agreement, it considered possible alternative systems, including adding pulsed azimuth to civil DME, or adding CW (continuous wave) azimuth to DME.

However the consultants reportedly rejected these for reasons of time required for development and/or their inability to meet military needs.

▶ **Hard Sell.**—Although it is not known what took place during Vortac meetings, since committee members were sworn to secrecy, it is not difficult to speculate on the things which made it

difficult for the military to sell their Tacan position.

• **Unreliability of Tacan,** although a characteristic of any new complex equipment in its early phases of implementation, proved particularly damaging when stacked up against VOR-DME, which has undergone a longer period of development and debugging.

• **Attitude of the military** in presenting Tacan as a "fait accompli" rubbed civil users the wrong way.

• **Fear on the part of civil users** that Tacan was the entering wedge to axe VOR, despite disclaimers by the military. Inasmuch as CAA already has implemented or has funds to implement nearly all of the VORs currently planned, and since upkeep should not prove expensive, it might be feasible to keep them in operation far beyond 1965. However, in view of what has happened to DME and the fact that Tacan offers a VOR-type service, civil users believe their doubts are well founded.

► **Interesting Contrast**—The transponder beacon program presents an interesting contrast. The military have a need to be able to identify civil aircraft on their air defense radar scopes. CAA needs to identify both military and civil aircraft to make better use of surveillance radar for traffic control, and to extend the effective range of radar in adverse weather. The civil and military transponder beacon needs are similar, but far from identical.

Yet, recognizing that we must live in the present Age of Peril, both groups participating in the ANDB's Advisory Group No. 2 have been able to work out a Common System civil transponder which meets the needs of all. If they had attempted to hammer out a Common System beacon, say, five years ago, before Korea, the result might have been far different.

► **Cooperation with Haste**—As it is, the transponder program is zooming along faster than expected. CAA has announced plans to install ground interrogators at five major airports, including the New York area, Washington and Chicago.

CAA's Technical Development Evaluation Center currently is trying several different approaches to the design of a civil ground interrogator antenna and decoder, to resolve certain problems which still remain.

Lake Central Airlines has equipped its fleet of six DC-3s with Melpar transponders for service test evaluation.

Aeronautical Radio, Inc.'s airlines electronic engineering committee has hammered out an acceptable spec for an airborne unit that is suitable for airline use.

At least four avionics firms are currently designing transponders for the airline and business aircraft market.

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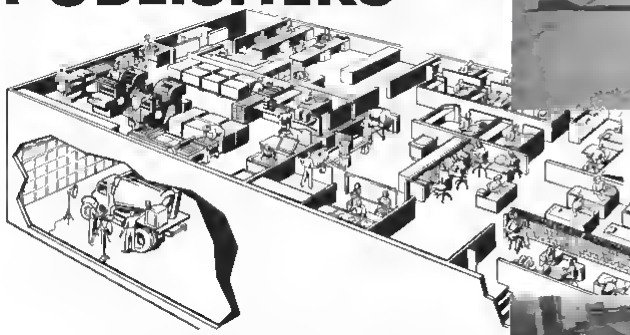

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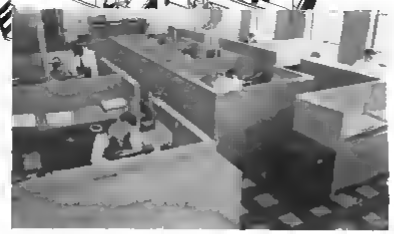

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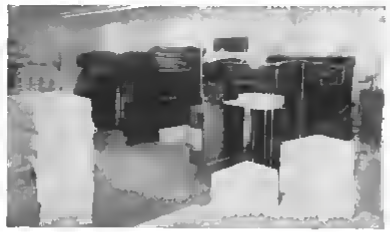

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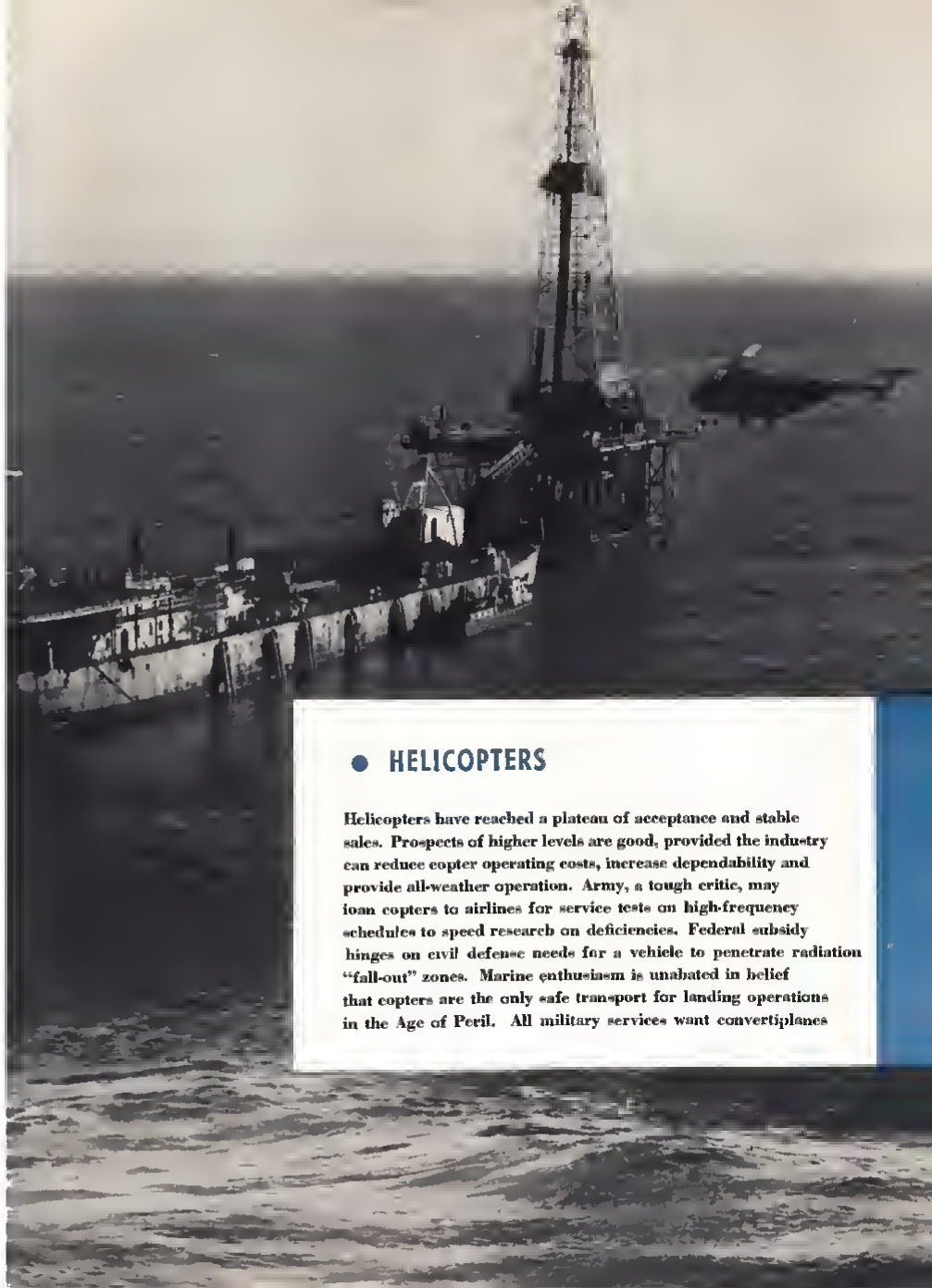

● HELICOPTERS

Helicopters have reached a plateau of acceptance and stable sales. Prospects of higher levels are good, provided the industry can reduce copter operating costs, increase dependability and provide all-weather operation. Army, a tough critic, may loan copters to airlines for service tests on high-frequency schedules to speed research on deficiencies. Federal subsidy hinges on civil defense needs for a vehicle to penetrate radiation "fall-out" zones. Marine enthusiasm is unabated in belief that copters are the only safe transport for landing operations in the Age of Peril. All military services want convertiplanes

PIASECKI HUP-2

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Military Holds Key to Copter Future

By Claude Witze

There is strong evidence of new and growing maturity in the helicopter industry

Like almost everything else involved in rotary-wing aviation in the past few years, this maturity was not a gradual thing. There was no slow dawning of a light. There was a near-explosion, detonated by the industry's customers.

Obvious parallel in many respects is found in the lightplane field. Blunt truth is that in the past few years the helicopter has been oversold almost as seriously as the light airplane was in 1945 to 1947. Big difference: the lightplane industry took it on the chin until its ambitions and output capacity were more closely in step with the potential market.

The helicopter makers do not face any immediate and painful contraction. But they must be more realistic, because their customers now have hard facts to check claims against.

Glib talk about taking the entire U. S. Army out of trucks and putting it in helicopters now is heard by officers who know how often a rotor blade has to be changed, how hard it is to change one in the field and that the new blades cost $1,800.

Equally glib talk about selling helicopter rides to all of the people who take buses, trams and autos for trips up to 250 miles in length—and this is most of the travel market—now is heard by airline operators who are both cost- and comfort-conscious.

▶**What's Ahead**—None of this darkens the picture for the helicopter's future, except in spots. The potential, both military and commercial, is stupendous and still growing. The Army, Navy and Air Force still are signing contracts. More aircraft are being sold to commercial operators, both in airlines and charter operations.

The 11th Annual Forum of the American Helicopter Society, to be held in Washington next month, will be devoted entirely to discussion of what the industry knows about commercial helicopter operations, what has been done and what needs to be done. It will be the first meeting since the Korean war, which put the helicopter in the air for good, that has seen the military take a back seat.

▶**Commercial-Military Interchange**—At the same time, it is highly significant that the military will be represented at this meeting. The reason: For the first time in the history of any vehicle, there is a strong possibility that military and commercial demands for a practical helicopter will, in the reasonable future, result in an equipment interchange agreement with a single purpose—to improve the state of the art.

While it is too early to speculate on the exact form this agreement will take, pending approval of a program that may have to go through Congress, serious thought is being given to the idea by the U. S. Army, the Air Transport Assn., individual airlines and helicopter manufacturers.

Recent draft of the program, approved by the ATA directors, recommended that three airline operators be loaned five types of equipment, one unit of each type going to each airline. The helicopters would be owned by the Army but flown and maintained by the airlines. The purpose: To speed development of improved rotary-wing aircraft through more widespread use and experience.

By 1954 it was a generally accepted fact that use of the helicopter in both military and civilian fields was being delayed by what one officer called "an attitude of pessimistic waiting that was doing nothing to solve the problems."

In the first 10 forums of AHS there were dozens of papers presented to show how the helicopter was going to solve everybody's transportation problem "after the operating costs had been reduced, after the maintenance requirements had been lessened, after the performance had been increased and after all the design bugs and voids in the state of the art had been eliminated."

▶**Common Needs**—While these papers were being prepared and delivered, military and commercial users—or would-be users—made the discovery that their demands on the industry were not different. It was not a case of fighter planes for the military and DC-3s for the airlines.

Their services, to be performed by the helicopter, have certain characteristics in common:

- **Short haul with frequent stops.**
- **Minimum ground servicing time.**
- **Rapid loading and unloading.**
- **Operation into and out of congested areas.**
- **Maximum dependability of service.**

In the search for these things, both military helicopter users and airline experts studying configurations and possibilities have been disappointed.

Said one Army officer during 1954: "The helicopter is a vibrating piece of machinery that requires too many overhauls."

Said one of the country's outstanding transport aircraft experts: "Our work indicates that aircraft of this type (helicopters) require installation of about twice the power of a comparable conventional airplane. . . . Such a machine does not seem to be the proper type for over-all use in short-haul operation."

"However, there are operations in metropolitan areas where competitive fares and time factors may well call for the profitable development of such local service. Present equipments in use are too small to have any chance of economical operation."

▶**Accelerated Tests**—Obviously, mere operation of military helicopters by commercial airlines will not in itself improve the aircraft to meet these objections or make it more adaptable for the mission characteristics shared by the two kinds of users. Purpose of the program is to provide a genuine accelerated service test of existing helicopters, a job that cannot be done by the armed forces.

A high frequency operation, carried out on schedule, is the only way design deficiencies can be uncovered with acceptable speed, maintenance techniques improved and over-all experience gained fast enough to benefit both customers and the industry itself.

Added impetus to this program may come later in 1955 as the U. S. revises again its civilian defense program to meet the threat of an H-bomb fallout that can contaminate 7,000 sq. mi. of territory. It is entirely possible that federal subsidization can be justified to get helicopters in the air as a rescue vehicle, the only one that can reach the interior of a fallout zone without being contaminated en route.

▶**Basic Studies**—While the practical approach is getting under way, basic problems of helicopter design and operation are not being ignored in the nation's laboratories.

Facilities of the National Advisory Committee for Aeronautics at Langley Field, Va., are busy on research into fundamental aspects of such things as two-rotor configurations, rotor blades, jet propulsion, increased rotor tip speeds, aerodynamics, loads and flying stability. Vibration remains the Number One headache, followed closely by other factors that contribute to the unsatisfactory short life of helicopter components.

Everything done at NACA is an effort to improve both commercial and military helicopters because the research agency, like the Army and the airlines, recognizes that advances are of equal importance in both of these fields.

Army

It is appropriate that Army, biggest existing and potential customer for the helicopter makers, is the customer that has been frankest in baring the weaknesses of present equipment.

All four major manufacturers—Bell, Hiller, Sikorsky and Piasecki—are represented in the Army stable. Only recently, Bell won a new design competition for an Army utility helicopter capable of hauling 800 lb. and with better performance characteristics than the Bell H-13 used commonly by foot soldiers in Korea.

Army also flies the Hiller H-23, comparable to the H-13 in size, the Piasecki H-25 and H-21C, and the Sikorsky H-19.

▶**Army Calls the Play**—Last spring Army called the manufacturers together and told them frankly that high operat-

SIKORSKY XHR2S-1

ing costs threatened to imperil the whole Army rotary wing program. Dependability, availability and economy all must be improved, Army declared, if the helicopter is to play the role predicted in providing mobility for ground troops.

The bill of particulars criticized complicated designs, difficult field maintenance, special tools requirements, lack of standardized parts and vulnerability to dust and dirt. The Army did not give out any figures on cost of maintenance but these have been circulated privately in the industry, giving a severe jolt to the design engineers and salesmen who have seen pie in the sky in recent years.

Army is determined to stick to its longrange program to provide front-line support in tactical operations with transport-type helicopters operating in combat zones that range from 50 to 100 miles in depth. This calls for helicopters in three payload classifications: light cargo (1½ tons), medium cargo (3 tons), and heavy cargo (5 tons).

For a complete program, Army will need 252 cargo helicopters for each field army, enough to lift a complete regimental combat team without its wheeled equipment. Operating in rough terrain with its present helicopters, the Army experiences 66⅔% availability.

Air Force

USAF currently is operating about the same helicopters used by the Army, but in smaller numbers and for more specialized missions. Air Rescue Service operates all over the world, on call to haul survivors out of isolated areas in case of accident.

▶ **Air Force Missions**—The intra-theater airlift mission involves troop carrier operations, cargo hauling, supply and rescue work. This is of particular importance in arctic areas, where not only accidents, but outposts such as radar stations call for communication with isolated spots, frequently in marginal weather.

Sikorsky's H-19 is looked upon by USAF as an interim helicopter, pending availability of larger designs. This year, after prolonged delays, deliveries of the Piasecki H-21B were started and soon they will be incorporated into the assault transport operation.

Air Force spokesmen, primarily concerned with fast fighters and longrange bombers, view the helicopter somewhat coolly as a Zone of Interior short-haul carrier. Only new use they can mention is the possibility that copters will find a place in supplying missile launching sites. For longrange planning USAF is interested in aircraft of better range, payload and speed.

Navy

Like USAF, the sea-going Navy uses helicopters for specialized missions: rescue, utility, submarine detection. In 1954, the American Helicopter Society gave its annual Kossler award to the Navy in recognition of progress made the previous year in adopting the helicopter for ASW activity. Since then, equally great advances have been made in minesweeping efforts.

Helicopters used by Navy include the Bell HTL, HSL, Piasecki HUP, Hiller HTE, Kaman HTK, HOK and the Sikorsky HO3S, HO5S, HO4S and HSS. The HSL, designed for anti-submarine work, is capable of launching a weapon.

▶ **Marine Enthusiasts**—Greatest helicopter enthusiasm in the Navy rests, however, in the Marine Corps. USMC officers at Quantico are more tolerant than their Army and Air Force brethren of the helicopter's limitations. They report that maintenance is a problem, but it is a less trying one with each new model delivered by the industry.

Secret of Marine enthusiasm for the helicopter lies in its potential as a carrier to insure success in beachhead assaults despite arrival of the atomic bomb as a tool of war. The Marines know that massed ships off another Iwo Jima could be wiped out with a single blast. A scattered fleet with helicopters to carry the troops ashore and place them where they are needed to fight will form a new unit called the "striking amphibious force." The necessary effort is to achieve dispersion for the ships and avoid the water line at the most critical time, that of the initial assault.

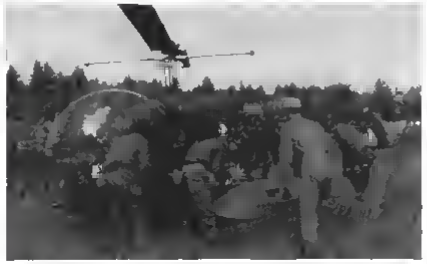
Landing craft, the Marines recognize, offer a lucrative target for atomic attack. Helicopters do not. This advantage holds for the provision of supplies to the fighting men after the battle is under way, and the evacuation of wounded. To facilitate this type of operation, the Marines predict conversion of battleships into carriers, protected by cruisers turned into missile launching stations.

▶ **Equipment Redesign**—Much Marine equipment must be redesigned so that it is transportable by helicopter. The aircraft itself must be of the transport category. At present the Marines favor the Sikorsky HRS, supplemented by the Kaman HOK for observation and liaison missions. These are replacing the Bell HTL and Sikorsky HO5S.

Next will come the Sikorsky twin-engine helicopter, the HR2S, not yet being delivered for operation. The manufacturer this year will open a new plant for assembly of this 26-man assault transport.

Copters to come, the Marines say, must have further improved perform-

BELL 47G SPRAY COPTER



BELL H-13G ARMY EVAC COPTER

ance and carry 6 to 7 tons payload Combat radius of the rotorcraft must be 100 miles

The Convertiplane

Talk to a military helicopter expert in 1955 and you will talk about convertiplanes There are none who will agree with those industry spokesmen who characterize the convertiplane as a poor helicopter and a poor airplane

The Air Force today looks upon the helicopter, at the working level, as an interim aircraft

The Marines want their big assault transport five or 10 years from now to have a speed of better than 200 knots

The Army's most outspoken helicopter enthusiast—and critic—Col William B. Bunker, last year was chairman of a working group of the Air Coordinating Committee that called for greater speed in convertiplane development The report emphasized both military and commercial applications of this type of vehicle

▶ **McDonnell and Bell**—To date, two convertiplane projects have been unveiled They are the McDonnell XV-1 and the Bell XV-3 Both are joint USAF-Army projects and both are small aircraft In addition, Navy is reported to have initiated development of a larger troop-carrier version to meet the Marine demand for something big and fast

Without attempting to define the exact state of the art today, there are some facts that are accepted by the ACC committee and other recognized authorities on the convertiplane Skirting carefully the danger of overselling, these appear to be

● **There are no technical obstacles** to the production of a satisfactory convertiplane of the unloaded rotor type Other configurations present problems calling for further research and development

● **All military services** need a convertiplane. Major requirement is for one that can carry 50 to 80 passengers at a speed of 200 to 400 mph

● **Commercial application** lies 10 years in the future The operating costs should be lower than those of a comparable helicopter, but higher than an airplane

Except in the closed ivory towers where design engineers wrestle with new aircraft ideas, little is said about the mechanical problems to be solved in development of a successful convertiplane It may be that perfection of the helicopter, a job that is keeping many people busy, will lead to the convertiplane as a logical next step

In addition to the official military projects already mentioned there are a fair number of private ventures under way and convertiplane enthusiasts are easy to find Their fast-growing professional group, the Convertiplane Pioneers, is carving a larger place for itself among the aeronautical specialty organizations

KAMAN NTK-1 TURBINE COPTER

PIASECKI H-21A RESCUE COPTER

Commercial

About 125 civilian helicopters were produced by U S manufacturers in 1954, a new record The figure compares with 110 in 1953 and a total of 490 in the years of 1946 to 1952 That is the whole history of commercial sales and at least 65% of the total represents aircraft exported to other countries

▶ **Copters in Service**—The total number of helicopters in operation in this country outside of the military, probably

does not exceed 150 Of these, only 20 are operated by certificated airlines As of last Sept 30, they were distributed among

- **Helicopter Air Service**, Chicago six Bell 47s
- **Los Angeles Airways**, three Sikorsky S 51s and four S 55s
- **Mohawk Airlines, Inc.**, Ithaca, N Y, one S 55
- **National Air Lines**, Miami, Fla, one S 55
- **New York Airways**, five S 55s

The remainder of the commercial helicopters are distributed among the small but fairly prosperous group of charter service operators who, after a few lean years, have found how to get more out of rotary wings than either the military or the airlines Secret of their success using the helicopter for highly specialized operations, for jobs that no other vehicle can do and charging a rate that insures a profit

There is a wide variety of equipment available for the private operator In addition to the standard Bell and Sikorsky models Civil Aeronautics Administration has issued airworthiness certificates for helicopters built by Cessna Hiller Kaman and McCullough Certification procedure is reported under way for a number of others, including aircraft made by Doman, Glenview Metal Products, Brantly, American Helicopter and Piasecki

▶ **Many Jobs**—The private operators haul cargo and passengers on construction projects, spray crops, patrol pipe and power lines carry out mapping, advertising and fishing projects The relatively new field of offshore petroleum drilling has opened a vast market for the operators of charter helicopter services

Airline operators universally lose money carrying passengers mail and cargo In some cases, such as the outstanding service provided by Sabena in Europe, the airline can prove that the loss in helicopter operations is more than returned by the additional traffic it feeds into the fixed wing trunk routes

In this country, helicopter passenger service is subsidized by mail payments, just as other airline service depends on federal payments from the Civil Aeronautics Board Importance of existing scheduled services is that they are building up a backlog of experience which is an essential requirement for further advances

Clearly the proposed program of lend-leasing Army helicopters to the airlines will permit an acceleration of this effort

▶ **Problems for Operators**—The standard short haul carriers the airlines who admittedly are in need of the much-hoped-for DC-3 replacement, seem to have lost some of their enthusiasm for the helicopter, pending development of a successful transport capable of carrying 40 or more passengers Practically all of them depend on subsidy for the success of their fixed wing operation Economics of the present day helicopter makes the substitution of rotary wings a fiscal impossibility for the short haul operators

In addition to the dollars-and-cents problem the would-be helicopter airline faces almost all of the maintenance troubles that annoy the military services And there are a few extras thrown in

- The helicopter is noisy, and unless it can land in downtown areas where few people want it today, its big advantage as a carrier is gone
- The helicopter to be successful in commercial service, must operate on time and in all weather Navigation aids and improved instruments must be provided
- The helicopter needs a downtown landing area Manufacturers feel that communities should delay final action on heliport plans until the airlines have specified what kind of performance they demand from the aircraft The airline operators, on the other hand, have indicated they feel the helicopter

should be designed to fit the heliport, not vice versa

▶ **Turbine Copters**—There is growing interest in the turbine engine as a possible answer to payload and vibration problems Bell, Kaman, Piasecki and Sikorsky have turbine-engine helicopters The Sikorsky S-59 in 1954 set new speed and altitude records, taking the honors away from the Piasecki H 21

Of greater import is the application of turbine engines to Piasecki's giant YH-16, 40 passenger tandem-rotor transport

First model, powered by two Pratt & Whitney 1650-hp reciprocating engines, still is undergoing flight tests Even before the program finished, announcement was made that the power units will be removed, replaced by turbines, under contract negotiated with the Army

Second Piasecki model, the YH 16A, soon will make its first flight It is powered by two Allison T38 turbines Indications are that success of the H 16 project, launched originally by USAF's Air Research and Development Command, may depend on its performance with turbine engines, which hold a tremendous advantage in providing increased payload

▶ **Guinea Pigs**—One of the refreshing things about the past year in the helicopter field, in addition to the growing maturity of the industry, is the frank admission of present commercial urban passenger carriers that they are the guinea pigs in a new and—at this time—perilous business.

The operations in Los Angeles, Chicago, New York and those by Mohawk and National, have resulted in a flood of useful information traded freely among the operators All of them are conducting services on a conservative basis that is a credit to their management.

There have been no bad accidents to raise the public eyebrow, there have been no loud screams about the noise nuisance and there has been good progress toward holding maintenance and operating costs at a minimum

In November 1952, the Port Authority of New York predicted the city's helicopter passenger traffic would be more than 6 million by 1975 Similar predictions have been made for a number of other areas

It is generally accepted now, 20 years before 1975, that these things still can happen and the New York dream will not dissipate like the postwar fantasy of a sky black with private airplanes

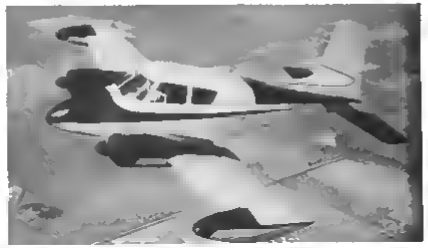
Saving that dream is up to the helicopter industry, which will have to produce the equipment to make the dream come true

• BUSINESS FLYING

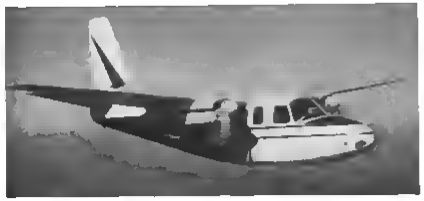
Key to America's mid-century managerial revolution, business flying continues to boom with no limit yet in sight. Over 18,000 business aircraft flew nearly 4 million hours and well over half a billion plane-miles last year. This year will be still bigger with industry raising its estimated $200,000,000 investment and $175,000,000 annual expenditure for equipment and maintenance.

Future prospects optimistically are put at 40,000 to 50,000 corporate-owned aircraft in 1965; conservatives say 24,600 will be the limit. Buyers still seek a multi-engine transport designed to business requirements. Even Cessna's new 620 is too slow at 250 mph.

BEECH TWIN BONANZA



CESSNA 310



AERO COMMANDER

PIPER APACHE

Business Flying Holds Steady Course: Up

The only aviation curve that doesn't bounce up and down is the one based on business flying statistics

It started to go up in 1946 and has climbed steadily ever since. The reason: Business flying is one of the keys to the mid-century revolution in American industry characterized by decentralization of factories and offices.

Undoubtedly there is a point at which the business flying curve will level off, but nobody will predict where that point is located. Industrial dispersion continues, stimulated in 1955 by the nature of thermonuclear warfare, municipal congestion, the tax situation, the labor market and the growing acceptance of the corporate airplane.

There are other factors. Most obvious is the general optimism of U.S. businessmen, who plan no curtailment of their investment in new plants and equipment. There is the sectional competition typified by the emigration of the textile industry from New England to the south and the boast of Puerto Rico that its products are delivered to any stateside market in 12 hours.

And U.S. corporation's have discovered they cannot afford to have high-salaried executives spend days in travel that could be accomplished in hours by air.

The growing complexity of American industrial products has brought a tremendous upsurge in the number of businesses that sell service, either unadulterated or in the same package with their machinery, electronic devices or chemicals. Pure service, of course, is provided by the consultants who are experts in engineering, management, labor relations, public relations, accounting or economics.

The scheduled airlines do not provide the travel flexibility needed by modern corporations—they must follow rigid schedules and serve only a bare 10% of U.S. airports. For this reason, it is estimated that business flying accounted for 3.9 million hours of airplane time in 1954. This was 44% of all flying outside of the military and scheduled carriers.

▶**Facts and Figures**—Statistics on business flying are not easy to get and there is no guarantee of their accuracy when they are uncovered. Best figures probably are those provided by the Civil Aeronautics Administration, but both the Aircraft Industries Assn. and the National Business Aircraft Assn. tend to be less conservative.

Newest CAA compilation, released two weeks ago, contains these facts:

- **There were 3.6 million hours** of business flying in 1953. Estimated increase in 1954 was 8.1% to 3.9 million hours.
- **Business flying is growing faster** than any other category.
- **Between 1946 and 1953** the number of hours flown in business transportation increased 3.4 times.
- **In 1953,** business transportation accounted for one million more hours than flown by all the scheduled domestic airlines.
- **In 1953,** 35,070 airplanes—57% of all in general aviation—did some business transportation flying.
- **Predominant in business flying** is the 4- or 5-passenger single-engine executive plane. This type accounted in 1953 for 1.7 million hours, 47% of the business total.
- **There were 5,930** one- and two-place planes used for business transportation, 10,630 of the larger single-engine aircraft and 1,650 multi-engine aircraft. There were 10 helicopters.
- **Of 18,220 business aircraft,** 9,470 were owned by corporations and 8,570 by individuals. Of the corporate-owned fleet, 7,670 were operated by companies not in the aviation business.
- **The 1954 estimate** of 3.9 million hours and 546 million plane-miles rolled up by business aircraft compares with 3.2 million hours and 518 million plane-miles flown by the domestic airlines.

▶**Still Booming**—There is no indication of any letup in the business flying boom. Some pessimists predicted that end of the excess profits tax in 1954 would ground a great many enthusiastic business fliers. NBAA spokesmen claim the end of the levy had the opposite effect and that the market for business aircraft has increased.

One estimate says U.S. business has $200 million invested in planes and is

RILEY-TEMCO TWIN NAVION

paying out $175 million a year for equipment, maintenance and other necessaries.

▶ **Equipment Complaints**—The entire subject of equipment is one that has kept the business flying market in a state of mild dissatisfaction ever since World War II. Biggest display of corporate aircraft in history, held last November in Dallas, lent emphasis to major complaint that there is no multi-engine transport designed with business flying requirements primary in the manufacturer's mind.

A growing number of improvements and power additions have been dreamed up for the venerable Douglas DC-3 and there is a substantial school that believes this plane remains the best bet for corporate buyers.

Typical DC-3 conversion provides Pratt & Whitney R2000-D5 engines, bringing cruise speed up to 214 mph. A new and lighter propeller, lighter exhaust, improved cowl flaps and integral steps also are added. With plush interior, the selling price runs about $275,000.

Converted or not, there are nearly 300 DC-3s in America's corporate fleet and they are a common sight at any fairly busy airport. From a standpoint of numbers, they are exceeded only by the famous Twin Beech Model 18, a much smaller and slower aircraft.

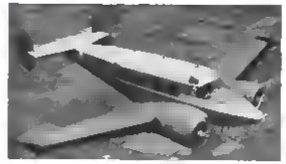
Other regulars serving corporations with a need for multi-engine reliability today, approximately in the order of their popularity, are:

• **Lockheed Lodestar.** The originals are wearing out and parts are hard to find. Lear Aircraft has introduced a converted Lodestar, nicknamed the Learstar, that is stripped down and souped up to make a comfortable 10-passenger transport. Elaborate Lear job runs cost higher than that quoted for converted DC-3, $350,000-$385,000.

• **Aero Commander.** A five- to seven-passenger transport with high wing. Basic price is $66,000.

• **Grumman Widgeon and Mallard.** Both amphibian, these are favored by companies that use their planes to carry executives and customers to hunting lodges and fishing camps.

• **De Havilland Dove.** Seats eight to 13 passengers. Built in England, it is powered by the manufacturer's own



BEECH SUPER 18

Gypsy Queen engines, cruises at 179 mph. Basic price $95,000.

• **Beechcraft Twin Bonanza.** Six passengers, $70,000.

• **Twin Navion.** Four passengers. It is a single-engine plane, modified into a twin; $28,500 plus the original airframe.

• **Cessna 310.** Five passengers; speed of 205 mph at cruising altitude, $50,000.

• **Piper Apache.** Four passengers, $32,500.

▶**New Beech.**—During 1954, Beechcraft introduced its new Super 18, vastly improved version of the original twin. Tagged at $99,000 for the basic aircraft without optional equipment, it has no more room than the much older D-18 but performance has been improved greatly.

Powered by two Pratt & Whitney R985 engines, cruising speed is about 200 mph. Range is well over 1000 miles. Interior comfort also has been improved providing more head room, larger windows, integral steps and soundproofing. There are seats for five passengers in addition to the crew.

▶**Cessna 620.**—None of these planes meets fully the requirements set down by NBAA for an ideal multi-engine corporate transport. Current white hope of the business pilots now appears to be the new Cessna 620, a four-engine business airplane that will be demonstrated to buyers later in 1955.

The Cessna 620 is tentatively priced at $300,000. It will have seats for eight to 10 passengers and will be pressurized for comfort at altitude. Power will come from four Continental GSO-526 engines of 320 hp. each.

NBAA is slightly disappointed with the Cessna 620 on two scores: the speed is given as 250 mph., less than the requested 300; and the members still are inclined to favor a two-engine configuration. Interest in the new plane runs high, however, and substantial sales are predicted once the performance is demonstrated.

▶**Foreign Designs.**—Two new foreign aircraft also deserve mention as potential members of the corporate fleet. They are the de Havilland Heron and the Royal Gull.

Like the Cessna 620, the former is a four-engine plane, powered by the de Havilland Gypsy Queen 30 Mk. 2 power unit. Available in eight to 17-

seat configurations, it cruises at 185 mph. Price of the Heron is quoted at $195,000.

The Royal Gull is a twin-engine amphibian, designed and used for many years in Italy. It was shown in 1954 by Royal Aircraft Co. of Milwaukee, a subsidiary of Kearney & Trecker Corp. This firm has plans to import the basic plane from Piaggio & Co., of Italy, install American components—including Lycoming engines—and sell the completed aircraft for about $65,000.

▶**Airline Types**—For the ultimate in corporate luxury and speed, as well as expense, it is possible to buy twin-engine Convair or Martin liners.

There are not more than 20 aircraft of this class now in private operation, flown for such corporations as the Chicago Tribune, Ford Motor Co., American Can, Union Carbide and Carbon, and a couple of major oil producers.

Properly equipped and ready to fly anywhere in the world, planes in this class cost about $800,000.

▶**Defense Aspect**—With today's emphasis on national defense, more attention is being given to another asset of the corporate-owned air transport system: its airlift potential in case of a national emergency.

MOBAF is the name of a plan drafted by NBAA and now under consideration as part of the national mobilization plan. It stands for Mobilization of Business Aircraft Fleet.

The program calls for preparation of contracts between the aircraft owners and the federal government for use of available planes for emergency military and civil defense missions in event of war.

A plan of operation has been proposed, under which pilots who were under contract would report their position at once and make themselves and their planes available to the director of a master aircraft control center. Missions would be assigned, depending on the location of aircraft and their capabilities.

▶**Predictions**—To estimate the exact size of the business aircraft fleet that will be available in some future year—possibly for an airlift in some future war—is perilous.

One guess is that by 1965 there will be 40,000 to 50,000 aircraft operated by 15,000 business firms. Another, more conservative, predicts 24,600 aircraft, 7,600 of them in the multi-engine class and 17,000 heavier single-engine planes fitted with three or more seats.

Thus much is sure: corporate or business flying appears likely to hold its place as the busiest sector of American aviation. There is no immediate prospect that the curve which started up in 1946 will turn the other way.

PIPER PA—18-A DUSTER

Farm Planes Move Into Spotlight

By Erwin J. Bulban

Agricultural airplanes, now putting an estimated extra $3 billion annually into the U.S. farmer's pocket, are heading out of their "supporting role" in the single-engine aircraft picture and shooting for equal billing with the industry's current "star"—the business plane.

This is one of the clearest of near-future trends in the lightplane industry.

In single-engine business planes, competition will continue to be fought in the salesroom rather than on the drawing boards

Do not expect any spectacular production gains in 1955—the number of units will be fairly close to 1954's total of about 2,600

Agriculture

Civil Aeronautics Administration reports that agricultural aircraft dollar volume is more than $50 million, although industry observers say that, because of faulty reporting by operators, a more accurate figure would be $60-$70 million

Dollarwise, this volume has been increasing some 10% annually for the past few years, and this steady growth is expected to show a sharper rate of increase in the near future, Central Aircraft, Yakima, Wash, one of the top spray/dust outfits in the U S, informs AVIATION WEEK

The country's agricultural fleet of over 7,000 planes is now helping to farm about one acre in every six in the U S Last year it dispensed more than 1 billion lb of dust and spray Aerial sowing is also on the upcurve Operators note that they are now sowing about 90% of all U S rice from the air

▶ **Time for New Planes**—Agricultural plane experts see these factors as speeding new spray/dust plane developments

• **Supply of surplus World War II trainers adapted to agricultural duties** is beginning to dry up, they say, presenting a market for replacements. Four years ago a Boeing-Stearman trainer, rebuilt, was priced at about $2,500 The same outfit today costs some $8,000. An ever tightening supply of P&WA 450 hp Wasps for these planes has boosted price of the engines to about five times what they were selling for only three years ago

• **Rising wages and fuel and maintenance costs** also pave the way for more economical built-for-the-job ships

• **Research by Fred Weick of Texas** A&M has sparked a whole generation of tailormade spray/dust planes, which are getting ready to take over from the modified workhorses Two years ago Weick's Ag 1 was the only new agricultural airplane design available It proved the predecessor of such new types as the Central Air Tractor, now in production, the Transland Ag-2, embodying much of the Ag 1's design principles; the Fletcher Utility, 100 of which have been ordered by Cable-Price Corp., New Zealand, where they will be shipped in prefabricated kit form, the Snow S 1, Weick's new experimental Ag 3 using Cub parts and designed for research on a 135 hp 800 lb payload low-cost design, and two modified L-19 liaison planes being field tested by Cessna following a market survey

Piper, long active in the lightplane spray/dust field with a high performance version of its Cub, expects a 100% increase in its agricultural plane volume in the next few years, says sales manager J W Miller.

WEICK AG-3 SPRAY/DUSTER

The Ag-3, incidentally, has been built mostly of parts contributed by Piper, and the company has been evaluating the ship It has visited the Piper plant at Lock Haven, Pa, and informed observers say that if the company decides to build a new spray/duster, the Ag-3 will be used as the basic design. Price is said to be about one-third that of Weick's Ag 1

▶ **Design Features**—The new breed of spray/dust planes will incorporate some or all of these features

• **Simplified all-metal structures** designed for in-the-field maintenance with a minimum of special tools Wear points will be readily accessible

• **Specially designed wheels and tires** will be used to take the hard knocks of agricultural operations

• **Segregated sealed cockpits** will have high G-resistance for pilot safety

• **Exceptional stability and sensitivity** of control close to the stall will be expected Good round-the-clock visibility is essential to avoid hitting trees, fences and other obstructions

• **Easily replaceable wing leading edges**, regular casualties in this type of flying, will be used

▶ **Materials**—Designers and builders are faced with combatting the highly corrosive action of agricultural chemicals on aircraft structures

Experiments by Weick on hundreds of materials and finishes show that only stainless steel and polyester fibrousglass reinforced plastic are completely unaffected by all of the solutions used in the tests Monel metal survives fairly well Aluminum alloy, chrome-molybdenum steel and brass are destroyed by certain chemicals

Best all-round finish for standard chemicals proved to be Carboline Co's gray Furan, but its primer was found to adhere poorly to steel, Weick says The trials indicate that Minnesota Mining & Manufacturing Co's Coro-Gard primer No 9, a chromate base type, shows good adherence to aluminum and steel

One of the toughest equipment problems ahead is properly designed chemical applicators Optimum spacing of nozzles for spraying and design of seed, dust or fertilizer distribution systems call for considerably more research and testing if most efficient, rapid and economical use is to be made of chemicals

Business Flying

All of the "Big Three"—Piper, Cessna and Beech—are optimistic about increasing their business plane dollar volumes in 1955, but this will be largely due to their new light twins getting into production stride this year

Mrs Olive Ann Beech, president of Beech Aircraft Corp, Wichita, predicts that the firm's 1955 commercial sales will be 25% higher than last year's record-breaking $20 million—but industry estimates are that Bonanza output will be fairly close to last year's 322 airplanes

The lightplane builders, scalded by post-World War II predictions, are cagy about guessing the market Although the lightplane is a proven businessman's industrial machine, relatively few customers are asking to be sold So the big load is on the sales teams

▶ **Sales Appeal Sought**—None of the top companies are talking about what they have on the drawing board The trend continues to increased horsepower, improved safety and styling to build sales appeal

New developments in the lightplane utility field would get their biggest boost if Army gained full cognizance over procurement of its aircraft, observers feel Then, they say, the close partnership between Army and the industry would quickly bear fruit that otherwise would ripen very slowly so long as Air Force, more interested in high performance weapons than transportation, is the ruling buying agency

Among the developments that surely would be hastened are use of turboprop and turbojet powerplants and installation of boundary layer control systems, providing far better small-field performance, longer range and higher cruising speeds

Customer preferences have resulted in several casualties in the lines previously offered by the top single-engine planebuilders

Piper acceded to overwhelming demand for its Tri-Pacer and dropped the companion Pacer with tailwheel

landing gear, then upped Tri-Pacer power from 135 hp. to 150 hp.

Cessna discontinued its four-five-place Model 195, explaining that a disproportionate sales effort would be required to justify carrying the plane.

Of the two Beech Bonanza models, the 225-hp. version, costing $1,000 more than the 205-hp. plane, reportedly has been outselling the latter by a very high margin.

► **Competitive Challenge**—Piper, Cessna and Beech continue to maintain their dominant positions in the single-engine field. But, as always, there are eager competitors.

• **Helio Aircraft Corp.**, Norwood, Mass., this year will initiate a distributorship organization to promote its four-place, all-metal, certificated Helio Courier. Featuring a speed range of 30-150 mph., the plane is price-tagged at $24,500.

The firm has signed an agreement with Mid-States Manufacturing Corp., Pittsburg, Kan., to produce a minimum of 300 Helioplanes in three years.

• **Mooney Aircraft, Inc.**, Kerrville, Tex., has been reorganized, and hopes to get production versions of the new four-place M-20 delivered early this year at $12,000 plus.

• **Taylorcraft, Inc.**, Conway, Pa., is making a strong effort to regain its position in the lightplane field with improved designs featuring a considerable amount of plastic construction.

• **Colonial Aircraft Corp.**, Deer Park, L. I., N. Y., is completing flight tests on its Skimmer three-placer, the only new amphibian currently making a bid in the single-engine business plane market at just under $16,000.

Personal Flying

The personal plane market remains the least sought-after by the aircraft industry. High costs have moved even the lowest-priced new two-or-four-place airplane far beyond the reach of the average sport pilot.

► **Do-It-Yourself Kits**—In some cases, pilots are turning to "build-it-yourself" projects, encouraged by a group of enthusiasts who have formed the Experimental Aircraft Assn. in Milwaukee.

• **Ray Stits' Flut-R-Bug**, which the designer states will be priced at about $500, minus engine, propeller and instruments. A single-seat midwing design with tricycle landing gear, Flut-R-Bug is planned for a 65-hp. Lycoming (priced at about $100) and has an estimated cruise speed of 90 mph.

• **Stits' Playboy**, a single-place kit which sells for about $995, and the two-place-Playboy, priced at $1,285.

• **Corben Baby Ace**, a single seater weighing 569 lb. empty, is being offered in kit or plan form by Paul H. Poberezny.

• FOREIGN AIRPOWER

Canadian airpower is expanding as that of most other nations lags. Cooperation with U. S. in continental defense and production of topflight aircraft, engines and missiles, mark Canada's record. Badly bogged British industry hopes 1955 will finally bring production of its prototype prides. Sales of the turboprop Viscount and engine successes offset the Comet's failure. Limited military budgets stifle French industry. Germany faces a long pull.

Continuing commercial airline expansion heralds tougher competition. Many airlines face extensive re-equipment.

AVRO CF-100 GETS COLD-WEATHER CHECK

Canada and U.S. Weld Air Defense Team

By Irving Stone

Canada—Canadian aviation policy and practice today emphasize two large and important factors—a sureness of growth and ever-closer teamwork with the U. S.

The course of Canada's air industry, which had a significant new birth in 1951, spells cooperation with the U. S. all along the way. It encompasses efforts from standardization of the smallest nuts and bolts, to broad cooperative philosophy affecting design, procurement, manufacturing, and down to the ultimate coordinated defense of the North American continent.

Never in the history of two sovereign powers has teamwork been so cordial or close during peacetime.

The only attack against North America that would seem to have any chance of success is by air. For this reason there is automatic and necessary collaboration between two of the top operational segments of the RCAF and the USAF—their Air Defense Commands.

RCAF's Air Defense Command, headquartered at St. Hubert, Quebec, comprises the most important operational element of home-base Canadian forces. It is still increasing its operational capabilities for maximum participation in the combined air-defense effort.

▶ **Combined or Separate?**—There has been considerable speculation as to whether a single, combined Continental Air Defense Command will come about for the two countries. At first glance a combined command would seem to be unnecessary, because it does not seem that cooperation between Canada's ADC and USAF CONAD (Continental Air Defense Command) could be any closer than it now is.

Nevertheless, there are various considerations involved, and top defense personnel in both countries have given the matter serious thought.

Canadian officials state that there has been no pressure exerted by the U.S. military to organize a combined command. Rather, it is admitted, that if a combined command emerges it probably will be through Canadian prompting, provided the request satisfies both the Canadian Government and its people.

The question resolves itself to one of urgency—whether it is necessary now to suggest a combined command to the political leaders, since these representatives would have the final say.

Students of the combined command situation say that such a command has not yet materialized because not enough empirical data had been available on which to base recommendations for such a continental system. This is so because a very large territory is involved. Also, the Air Defense Commands on both sides of the border have not been in existence long enough to gain sufficient experience to evaluate all the pros and cons.

▶ **Cooperative Defense**—There is little doubt that even as separate units the two commands will continue to work together as efficiently as they have in the past. There is equally little doubt that this teamwork could be even more efficient under a combined continental air defense setup.

The advantages of such a combination would be almost entirely military. The combination would permit:

• **Ability and freedom** to look at the continental defense problem with an added ease—as an integrated picture—without the necessity of having at all times to maintain an awareness of national boundaries.

• **Additional freedom in deployment of** weapons, greater uniformity of organization and techniques. Submergence of certain national tendencies would not always result, but by and large the move toward these standardizations would pay big dividends.

• **Uniformity** in phasing and completion of projects. Already, both commands have come a long way just by working side by side on such items as target dates, practice, organization and communications.

Even with separate commands, as at present, in an emergency a military decision could be made in a matter of minutes, because the structure of cooperation already is a fact.

▶ **Coast-to-Coast Setup**—Operational arena of RCAF's Air Defense Command is coast-to-coast in Canada. Most westerly unit is on Vancouver Island and most easterly is in Newfoundland.

In the east, a unique arrangement exists—USAF's Northeast Air Command (a joint Air Force-Army-Navy command) has its operational control exerted by RCAF's ADC. This is by agreement, and relates only to the Eastern Air Command's air defense arm.

Sandwiched between the Newfoundland and British Columbia outposts are two other divisions of Canada's ADC. One comprises the Maritimes, Quebec, and Ontario regions, which are organized and divided into Canadian sectors. The other involves the Prairie

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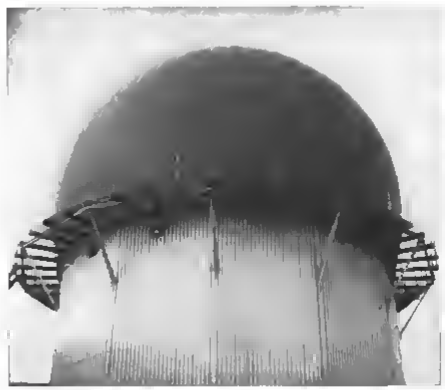


RADOME HOUSES RADAR EYE

CF-100 DELIVERY LINE

● CANADA

Provinces, and these are not yet organized into ADC sectors. The reason is that the area is not considered critical nor to lie above a critical area of the U.S.

▶ Teamwork—Examples of cooperation between the air defense commands of the two countries start at headquarters level, where a system of officer exchange is maintained. Also, there is an almost constant interchange of visits by planning and operation staff teams.

Operational data on initially "unknown" aircraft passing into Canada from the outside is constantly recorded and passed on to the appropriate U.S. Air Force CONAD control centers.

The number of unknowns in the system is a matter of utmost importance. The idea is to identify each aircraft—is any specific craft friendly or an enemy? The number of unknowns which are not identified before landing has constantly been decreasing. This is a measure of the growing efficiency in the overall Canadian identification effort.

The ultimate efficiency Canada is aiming for in aircraft identification is still far away and is dependent on many factors—improved communications, additional legislation and aids for civil air traffic control, and more extensive military experience.

Cooperation extended by European airlines has been very commendable, more so than that exhibited by North American carriers in reporting their positions to control centers, Canadian sources say.

USAF's Strategic Air Command, in its training flights across Canada and down to the States from far points, provides plane targets for RCAF's interception practice.

If Canada doesn't have a plane handy for this interception, the radar will turn the intelligence over to USAF for interception by its planes.

Or, the Canadian radar may ask an American plane cruising over the States to do the interception job. In this mission, the USAF craft may even land at a Canadian base to refuel.

▶ **Participation Will Increase**—Joint exercises are important for the air defense team. There has been a major exercise each year, in which SAC generally has furnished the majority of targets. In these exercises, all tabulations and results are exchanged, and the analysis is conducted jointly by both commands.

Smaller-scope exercises are conducted constantly—almost daily. These are arranged by lower level echelons, such as sectors and air divisions.

Canada's participation in these exercises has been and will be directly proportional to the amount of interceptor-type aircraft and crews that it will be able to muster. These planes

SIKORSKY S-55

and personnel are on the increase now and 1955 will be the most significant single year of buildup for RCAF all-weather interceptors on the basis of full operational reliability.

The Avro CF-100 Mark 4 all weather interceptor is now pretty much "bug-free" and high air officials are quite optimistic about the potential of the plane. Its operational characteristics have improved far beyond what was expected. Canadian aircrews all like the plane.

▶ Exchange Students—RCAF's ADC personnel enroll in USAF courses available to them. Some of these courses are paid for by Canada.

For example, for intercept controller training (GCI), Canada's ADC pays the U.S. about $1 million. This training involves flights to provide targets for the trainee controllers, and is considered a good buy, because it is much cheaper than building and maintaining such a training school in Canada.

Other courses deal with electronic countermeasures (ECM) and airborne interception (AI).

▶ Equipment Loan—ADC also gets property for loan and tryout from USAF. For example USAF has lent and installed radar equipment in Canada, has lent communications equipment and training aids. The radar generally goes to locations which Canada would not be able to supply until some future date.

This loan arrangement is to the mutual benefit of both air arms—it gives Canadian forces an opportunity to study U.S. equipment and gives the USAF increased depth of coverage.

Eventually this radar equipment will be turned back to USAF and be replaced by Canadian equipment.

Spare USAF runway barrier equipment also has been delivered to Canada to help overcome the short runway disadvantage of CF-100 operation in winter at a particular site.

Because Canada uses VHF equipment, it receives UHF from USAF on loan to help RCAF stations communicate with USAF planes—help them land, or do interceptions over Canadian territory.

This UHF equipment gives RCAF's communications and control personnel additional opportunity for training since they have relatively few planes in the air and these carry only UHF. The UHF-equipped USAF planes provide for this additional training in conjunction with the loaned UHF ground equipment at Canadian bases.

▶ Eyes Across Canada—In the buildup of RCAF capabilities, top emphasis has been placed on early warning installations.

Already in operation in Canada is a control and warning radar chain extending across the northern points of Ontario, Quebec, and Labrador. This is known as the Pinetree Chain. Pinetree, completed after about four years of work, is operated jointly by Canada and the U.S. Cost of this radar line is about $300 million, with about two-thirds of this cost being borne by the U.S.

General plan is for U.S. personnel to man those stations which stand athwart of the approaches to American industrial centers while Canadian personnel staff the stations guarding the path to vital Canadian centers.

Pinetree has a double function—it not only can detect enemy aircraft, but also functions to control fighters engaged in the task of interception.

▶ Mid-Canada Line—Additional early warning facilities, generally to the north of settled territory in Canada, are believed to be located roughly along the 55th parallel.

Known as the Mid-Canada Line, or the McGill Fence, it will be largely automatic, that is, unmanned to a degree. This line is equipped with devices mainly developed specifically by McGill University in cooperation with Canada's Defense Research Board.

It may be safely conjectured that this equipment is different substantially from general types commonly used for radar work. This line's description as a "warning" line (as distinguished from a control and warning installation) leads to the conclusion that it will not be able to discriminate between friend or foe, as Pinetree will.

The Mid-Canada Line apparently exists to give sufficient alert for a type of aircraft such as the Soviet Tu-4—a 250 knot plane.

Its description as a warning line obviously means that fighter bases are not located along the site or nearby—the expense involved would be far too great for such installations in the far north—both for initial construction and for supplying and holding such a base.

Canada is financing, constructing and will operate the Mid-Canada Line—an indication that the overall installation is a less expensive system than Pinetree.

▶ DEW Line—Late last year plans were announced for the construction of a Distant Early Warning (DEW) Line across the far northern part of North America.

This system, probably located along the 70th parallel, is for alerting against newer, faster bombers with a speed at least double that of a type such as the Tu-4. Although both Canada and the U.S. will participate in the DEW project, responsibility for the construction and installation of equipment will be the job of the U.S.

Portions of the complete warning and control system in Canada probably will be extended seaward on both flanks of the continent by the U.S. One reason for extending a warning line, such as the DEW line, out to sea would be to tag enemy bombers that might come down along seaways to bypass the land alert installations.

Construction of the lines alone will not be the ultimate answer. Big problems of operational coordination lie ahead. A constant alertness will have to be maintained to guard against probing or mischief missions by potential enemy aircraft.

▶ **Defense Buildup**—Beginning early in 1951, Canada's Department of National Defense planned an expansion which would cost about $5 billion in about three years. In the main, RCAF's role in the program has been closely realized, and in addition plans have been extended well beyond the 1951 conception.

The situation is fluid, changing all the time with new developments such

as the assumption of responsibility for the Mid-Canada Line and actual implementation of the C-105 delta-wing interceptor program. Both these items are considered additions to the original plan, and others undoubtedly will enter the picture as long as the present international situation exists. To date, more than $3.5 billion has been committed for RCAF expenditures alone.

Obviously the RCAF cannot be compared in overall strength and capability with the USAF. Nevertheless, RCAF probably stands as the fifth or sixth ranking air force in the world at the present time.

▶**Strength Estimates**—Estimated strength of the regular RCAF as of the end of 1954 was approximately 48,000 personnel members. A comparable figure for Mar. 31, 1951, was 22,359. Total strength of the RCAF auxiliary now stands at about 5,500. In addition to these RCAF personnel, there is a Ground Observer Corps encompassing about 80,000 members.

At the time of this writing, RCAF is at or is very close to its buildup target of 41 regular and auxiliary squadrons.

Included in these 41 units are 12 NATO Sabre Squadrons, which make up the RCAF NATO Air Division. The report is that about 300 planes are involved for all 12 squadrons.

The Orenda-powered Sabre is considered by many observers to be the most effective fighter in the NATO Air Forces on the European continent. It is described as the only fighter in squadron service with NATO in Europe capable of coping successfully with the latest MiGs.

In addition to the NATO squadrons, there are 12 auxiliary squadrons, 4 transport squadrons (Nos. 426, 435, 436, and 412) flying C-119s, North Stars, or Dakotas, etc., 1 photo recon squadron (No. 408), 3 maritime squadrons (Nos. 404, 405, and 407).

Total of these squadrons is 32. Subtracting this number from the buildup figure of 41 leads to the conclusion that there are 9 all-weather squadrons operating with CF-100s. This plane, probably the most heavily armed interceptor today, is considered as good an aircraft of its type as any in service anywhere.

Procurement

Canada's procurement of aircraft has a logical base, dictated mainly by the economics of the country and its level of industrial capacity. It isn't likely that Canada would broadly enter design fields which would be in competition with aircraft available in the U. S. or the United Kingdom.

▶**Where To Buy It**—Ultimately, the controlling factor would seem to be whether those designs obtainable outside of Canada could meet the required performance and the operational target dates.

It can be assumed, therefore, that Canada could not obtain from outside sources the equivalent of its CF-100s or the C-105s, when these designs were laid down.

The feasibility of getting types from outside Canada is pointed up in the procurement of the Lockheed P2V-7 for maritime reconnaissance service, as well as the McDonnell Banshee to replace the Sea Fury in the Royal Canadian Navy.

Canada is building the maritime reconnaissance version of the Bristol Britannia and the anti-submarine-warfare Grumman S2F probably because sufficient numbers of these planes are involved to justify the expense of setting up tooling and manufacturing the articles at home.

Similarly, the Lockheed F-104 probably will be built in sufficiently large numbers at Canadair to replace the Sabre now being built by that company under license.

There are advantages in getting plane designs from the U. S.—engineering practices are the same and lines for supply and liaison are short. It is obvious that Canada is aiming to obtain operational type of aircraft and equipment that would not be dependent on overseas supply centers for replenishment. Of course, it would be desirable to obtain everything in Canada, but obviously this isn't feasible.

▶**Defense Production Agency**—Big factor in Canada's military effort is its Department of Defense Production (DDP). Its function is to procure materiel of war for Canada's armed services. Thus, when RCAF specifies what is to be procured, DDP's job is to get the material. It has discretion as to source and the contractual negotiations for obtainment. It also follows up deliveries and expedites them.

DDP maintains an office in Washington, D. C., for procurement of planes and equipment from USAF or USN, or from a contractor directly if it is cleared by the U. S. military.

In many cases, equipment obtained by DDP might be a straight diversion from a U. S. military order. An example of this is the Lockheed P2V-7 Neptune, obtained for RCAF's maritime reconnaissance service.

▶**Licensing Arrangements**—If RCAF's requirement is for a sizeable run of aircraft or other equipment, DDP will try to negotiate a license to have the articles made in Canada. These negotiations would be with the American manufacturer who has the proprietary right and with the Canadian manufacturer selected to make the articles. This Canadian manufacturer is made the agent of the Crown to receive the technical data.

Thus, DDP might negotiate an agreement with a U. S. manufacturer to make the airframe in Canada, have the landing gear made in the States, and the engines in Canada.

A separate activity of DDP is the procurement, under requisition, of electronic, armament, general stores, etc., as distinguished from the material obtained by the organization's aircraft branch (which covers, generally, complete aircraft, engines, props, tires, tubes, landing gear, wheels, brakes, engine accessories, training aids, development items, etc.).

This other material, such as electronic gear, is extracted for the appropriate branch in DDP for procurement. This is done because these branch activities are staffed with experts with special knowledge in the specific field of procurement.

▶**Migrations to Canada**—DDP's procurement policies have contributed greatly toward self-sufficiency of Canadian industry. A large number of U. S. and U. K. industry subsidiaries have been established in Canada since the war and have contributed considerable know-how.

Such companies include Lucas-Rotax, Sperry Gyroscope, Rolls-Royce, Bristol Aeroplane & Engines, Ltd., Dowty, and Ferranti, Ltd.

▶**Repair and Overhaul**—Nearly all repair and overhaul work for RCAF planes, engines, equipment, is done by civilian facilities chosen by DDP, in collaboration with the RCAF. This civilian effort represents a substantial secondary and supporting industry to the prime producers.

In many cases, these civilian overhaul and repair organizations have subcontracts for the manufacture of parts, and have proven particularly valuable in supplying articles no longer being manufactured.

▶**Agent in Canada**—DDP also acts as the civilian agency of other governments at their request.

Thus, for USAF procurement in Canada, the Canadian Commercial Corp., a Crown company with an office in Washington, places requisitions with DDP, for the latter to do the actual procuring. It was under this arrangement that the de Havilland Beaver and C-47 spares were obtained for USAF.

There is a reciprocal inspection agreement for air force personnel of each country to check on the quality control of procured items on behalf of the procuring service. Thus, USAF will inspect all RCAF equipment obtained, for example, in Detroit, and RCAF

will check equipment USAF gets in Canada.

▶ **Collaboration**—There are numerous other examples of cooperation between RCAF and USAF. Because the RCAF is a smaller service, it is likely that in all this interservice collaboration, it will profit most. Some outstanding examples of how the two air forces work together:

• **Requirements interchange program.** Cooperation in this field has increased greatly over the last few years. Purpose of the program is to effect as much standardization as possible between the two services to simplify logistics and mutual assistance. Items involved could include aircraft, hardware, electronic equipment, armament, accessories, fittings, pressure suits, and could extend to establishment of standard pressures for oxygen feeding, for instance. A similar program exists between the RCAF and RAF.

Everything done from a requirements point of view relates to forecasts far in advance of today's needs, and is drawn up by RCAF in draft form, then sent to opposite numbers (directors of operation requirements) in USAF and RAF. These examiners provide the RCAF with constructive comments. In a reciprocal arrangement, RCAF sends comments to USAF and RAF on their requirements.

The entire collaboration tends to lead to standardization between the three services, but more likely between the RCAF and the USAF because of the proximity of the two countries and available common sources of supply. USAF and RAF have officers stationed in RCAF headquarters for this collaboration, and Canadian air officers are stationed in Washington and London.

After rough draft comments are resolved, a final General Air Staff requirement is prepared as a guide for development and engineering staffs of the RCAF, so that specifications may be written for equipment which has been selected for development.

The specs are approved by the Air Staff's Directorate of Operational Requirements, which also monitors tests on equipment and jointly with the engineering staff accepts or rejects the developed items.

• **Officer exchange program.** This interservice cooperation exists for the exchange of officers from flight lieutenant (equivalent to captain, USAF) through wing commander (equivalent to lieutenant colonel). Extended substantially over recent years, the exchange program is a three-way collaboration—RCAF, USAF, and RAF. Canada may have as many as 50 officers actively involved in the swap under the exchange arrangement, at USAF and RAF stations.

Pretty much every phase of activity is represented in the exchange program. RCAF, for example, has officers in USAF or RAF fighter and bomber squadrons, maritime activities, armament, air and ground training, aircraft maintenance, and supply. Both flying and staff positions are involved.

One example of a special deal was in Korea, where 21 RCAF officers flew with USAF F-86 squadrons, at various times.

Through the exchange, officers become generally familiar with the operation of a corresponding service in another air force. This could ease emergency situations and promote efficient collaboration. Also, the exchange frequently results in a new slant on difficult problems which the visited air force already may have encountered and solved.

Period of exchange duty now is two years. During this time the officer reports to the commander of the host force insofar as his function is concerned. Administratively, he is serviced by his government's military agency in the capital of the host country.

Each officer makes reports to his parent service. These reports are circulated to interested agencies or directorates and an appointed correspondent in the parent force is responsible for reply to the exchange officer and for requests of any other information.

• **Cold-weather testing.** Canada's Central Experimental and Proving Establishment's climatic detachment, located at Namao, Alberta, proves aircraft, accessories, and almost any associated equipment for cold-weather operation.

Some of the results of this climatic testing automatically go to USAF, but all reports are available to it on request. CFPE's climatic detachment, in turn, has access to USAF's cold-weather station.

Tests may cover complete aircraft, or they may be on engines, clothing, batteries, lubricants, gaskets, ground equipment, oleos, hydraulic installations, defrosting equipment, tolerances between parts where there is relative motion.

Aircraft checked out generally are early production types although prototypes may also be included.

Armament is not included, since testing of this equipment is done by a separate experimental group.

Tests show up operational bugs and indicate the need and extent of modification.

• **Survival courses.** Canada's survival school is located at Edmonton, Alberta. Aim of the training is to give survival instructions to all air crews. Priority is given to men involved in northern flying.

American personnel, particularly from USAF, have been given this survival training since 1950. Between Apr. 1, 1954, and Oct. 1, 1955, RCAF has agreed to take in this training phase almost 350 personnel from the United States Air Force, Navy and Coast Guard.

The training is divided into two phases—a bush phase of 14 days duration, and an arctic phase lasting 7 days, if taken concurrently with the bush phase. During the winter months, the bush phase is given at McCloud River, Alberta—162 mi. west of Edmonton. During the summer months it is given at Entrance, Alberta—220 mi. west of Edmonton.

The arctic phase, given only during the winter months, is conducted at Cambridge Bay, within the Arctic Circle.

Training is given as early in a pilot's career as is feasible.

Industry Picture

Canada's general aviation status reveals these highlights:

Biggest aircraft manufacturing employer is A. V. Roe Canada, Ltd., Malton, Ont. This company, one of the British Hawker-Siddeley Group, formed three separate branches late in 1954—Avro Aircraft, Ltd., Orenda Engines, Ltd., and Canadian Steel Improvements, Ltd.

• **Avro Aircraft, Ltd.,** employing 10,000 people, is producing the CF-100 Mark 4, a rocket-firing twin-engine jet fighter. More than 300 of these planes have been turned out for the RCAF.

Avro is tooling up for the new delta wing interceptor C-105. Two prototypes have been ordered by the Canadian government. First is expected to be ready this year, with production scheduled for 1960. The plane will use Pratt & Whitney J57 jets in the prototype, while production models are slated to get the Avro Super Orenda PS13. The C-105 is designed to have the speed of 1,200 mph., range of 1,500 mi. Its armament is to include Canadian developed air-to-air Velvet Glove guided missiles.

Avro Aircraft engineers are also at work on other guided missile designs, are doing electronics work in connection with radar fire control of guided missiles and planning jet trainers.

Under study is an advanced version of the commercial Avro Jetliner—prototype was completed shortly before the outbreak of the Korean War but the plane was never placed into production.

Avro is continuing research on the "flying saucer." The Canadian government is not financing the project—Trade Minister C. D. Howe has said it would have cost $75 million to get a model of the plane into the air.

• **Orenda Engines, Ltd.** has 6,000 employes, and has turned out over 1,500 Orenda jet power plants—the first jet engine mass produced in Canada. In addition to powering the CF-100, it is used in the F-86 Sabre now being built by Canadair, Ltd., Montreal.

The company's new jet development, the Orenda PS13, embodies substantial amounts of titanium. It is a twin spool, axial flow jet expected to have a thrust between 15,000-20,000 lb. More than $4 million has been spent on its development so far.

• **Canadian Steel Improvements, Ltd.** is closely associated with Orenda Engines, Ltd., and produces high quality forged blades for jet powerplants. Expansion planned for 1955 includes use of new 10 ton gravity drophammer and other equipment for making large forgings in high strength aluminum and titanium alloys. A new foundry also is being built. Company currently employs about 400 people.

▶ **De Havilland**—Oldest established Canadian aircraft plant is de Havilland Aircraft of Canada, Ltd. In 1954, the company moved into a new $7 million plant at Downsview, is now producing the single-engine L-20 Beaver and Otter for the RCAF, USAF and many other governments.

By year end, 700 Beavers had been produced and placed in use in 28 countries. The company was working on a USAF order for the 14-passenger Otter for liaison, ambulance and transport use. Order is believed to be for

about 90 planes.

DH is tooling up for production, under license, of the Grumman S2F subhunter for the Royal Canadian Navy. Work on the order, reported at over $40 million, is expected to be well underway by the end of 1955, with deliveries scheduled for 1956 to coincide with the delivery to the Royal Canadian Navy of its new aircraft carrier HMCS Bonaventure.

The company will build the fuselage and other components for the aircraft, while wings will be built at the Fort William, Ont., plant of Canadian Car & Foundry Co., Ltd., and tail assemblies at Enamel & Heating Products, Ltd., Sackville, N. B.

DH has taken over the former Canadian General Electric Co. plant at Downsview, built for overhaul of J47 jets, and will service these and British DH Goblin jets there. It also plans an overhaul base for its various aircraft at Vancouver.

The company is set up to sell the Dove, Heron and Comet in the U. S. and Canada—planes made by its British parent company.

▶**Canadair, Ltd.**—This Canadian subsidiary of General Dynamics Corp. produces the F-86 Sabre (more than 1,500 built to date), the T-33 Silver Star, and is tooling up to make a maritime reconnaissance version of Britain's Bristol Britannia for the RCAF.

Fifty of these Britannias will be built at a cost of about $185 million. The aircraft will be powered with Wright R3350 Turbo-Compound engines to give it low-altitude performance and long-range characteristics. It will be the biggest plane ever built in Canada, and it is expected that the order for the 50 aircraft will be completed by 1961.

RCAF has plans to order one or more Britannias as transports, and there has been unofficial talk of a turboprop-powered version being ordered by Trans Canada Air Lines for trans-Atlantic service.

Canadair employs about 11,000.

▶**Rolls-Royce of Canada, Ltd.**—This Montreal firm is producing the Nene jet engine for the T-33 Silver Star trainer. Nine hundred of these engines were ordered, 50 of them to be built in Canada. These are now coming into production.

The company also will service and supply parts for the Rolls-Royce Dart turboprop engines for the TCA-operated Vickers Viscounts.

▶**Canadian Pratt & Whitney, Ltd.**—This company is starting production, at Montreal, of the Wright R1820 radial engine for the Grumman S2F subhunter being built by DH.

It also is building the R1340 Wasp engine for RCAF and USAF, at about 60 a month, plus spare parts for about 25 a month. About 2,000 are employed at the plant.

▶**Bristol Aeroplane Co. of Canada**—At Montreal, Winnipeg and Vancouver, this company is engaged primarily in overhauling various types of engines for RCAF, TCA and RCN.

Bristol has about 800 employes.

▶**Fairey Aviation Co. of Canada**—Located at Halifax, this company employs about 1,000 people for servicing fighters (Avengers and Sea Furies) for RCN. Lancaster reconnaissance aircraft also are being serviced for RCAF.

The company is expected to do some modification work on the 25 Lockheed P2V-7 Neptune RCN is getting, and also will service these aircraft.

It is reported that when the Grumman S2F aircraft come into service in Canada in 1956, Fairey will also service these.

Plans are believed to be underway for opening a branch to service RCN aircraft at Vancouver.

▶**Canadian Car & Foundry, Ltd.**—At Fort William, Ont., this company is producing the Beech T-34A trainer for RCAF and USAF. This plane has been named the Mentor and is being used for initial pilot training. About 100 have been ordered by USAF.

The company finished production of Harvard advanced trainers early in 1954.

▶**Other Firms**—At Montreal, Canadian Aviation Electronics recently opened a new $3-million plant for manufacturing flight simulators, subassemblies for guided missiles and other avionics equipment.

In the Toronto area are a number of prime suppliers of components. Dowty Equipment of Canada, Ltd., subsidiary of a British company, makes nose wheel and main undercarriage units and complete hydraulic equipment for the CF-100. Dowty also makes Dunlop wheel and brake units for this plane and tail wheel shock absorber units for the de Havilland Beaver.

Lucas-Rotax, Ltd., also a subsidiary of a British organization, has plants at Toronto and Montreal making fuel systems for the Avro Orenda engine and the Rolls-Royce Nene engine used in the T-33. It also is producing the Lucas proportional flow control system for the Orenda and is doing some work on guided missiles.

Fleet Manufacturing, Ltd., at Fort Erie, Ontario, is making components for the CF-100, the F-86 Sabre, nose wheel landing gear for the Republic Thunderstreak, and components for the Doman helicopter.

Canada Set to Start Turboprop Operations

In the next few weeks, Trans-Canada Air Lines will start its first scheduled operations with turboprop airliners. TCA will provide daily services on its Montreal-Toronto-Winnipeg and Toronto-New York daily services with British Vickers Viscount aircraft, the first of which reached Canada last December.

TCA expects to have 15 Viscounts in service by May on a number of routes—mostly to the U. S.—including Montreal-New York, Toronto-Cleveland and Toronto-Chicago. Aircrews have been in training for these aircraft since the beginning of the year when the second of 22 Viscounts was delivered at Montreal.

Maintenance crews have been familiarizing themselves with the Viscount and its Rolls Royce Dart engines at the main TCA overhaul base at Winnipeg.

▶**Super Connies and Freighters**—In 1954, TCA began to use two other new types of aircraft. It has seven Super-Constellations based in Montreal for use on both the trans-continental Montreal-Toronto-Winnipeg-Vancouver service, and its Toronto-Montreal London-Paris-Duesseldorf trans-Atlantic service.

On the trans-Atlantic run the aircraft is used in a combination tourist-first class service on the transcontinental run it is first-class only.

Trans-Canada also began using three Bristol Air Freighters on its Montreal-Toronto-Winnipeg and Montreal-New York routes. The aircraft are used exclusively for cargo. It has inaugurated a twice-daily truck pickup service at Toronto, and will expand to other cities, to handle air cargo.

Largest airline hangar in Canada was completed in 1954 for TCA at Toronto's Malton Airport. At Winnipeg, TCA has built a special engine test house for servicing the Rolls-Royce Dart engines on the Viscount.

TCA president F. R. McGregor reports that the airline carried 1,429,000 passengers in 1954, up 9% over 1953, and that revenue passenger miles were up 12%, to 850,952,000 miles. He announced start of a five-day-a-week trans-continental freight service this year, and reported a 35% increase in air-freight ton-miles for 1954 over 1953, for a total of 8,340,000 ton miles. In addition to its Super Constellations and Bristol Freighters, TCA had 22 North Star DC-4s and 27 DC-3s in service.

▶**Canadian Pacific Airlines**—Operating domestic scheduled services into Canada's northland, and trans-Pacific and Latin-American services out of Vancouver, Canadian Pacific has added no new routes in the past year. It has applications pending for service from Lima to Santiago, Buenos Aires and Rio de Janeiro in South America, and for a trans-Polar route from Vancouver to Amsterdam.

It uses DC-6B aircraft on its international service, DC-3s, DC-4s, Convair, and smaller planes on its northern Canadian service. Its plans for use of de Havilland Comet jet aircraft on its trans-Pacific services have been delayed, but it still has orders in for six Comet airliners.

▶**Other Lines**—A number of regional Canadian scheduled airlines on the Pacific and Atlantic coasts as well as close to 100 charter non-scheduled Canadian airlines had a good year in 1954.

New aircraft were purchased by a number of these smaller operators, and a few are supplying nonscheduled charter helicopter services, especially for mining survey and transport service into otherwise inaccessible areas.

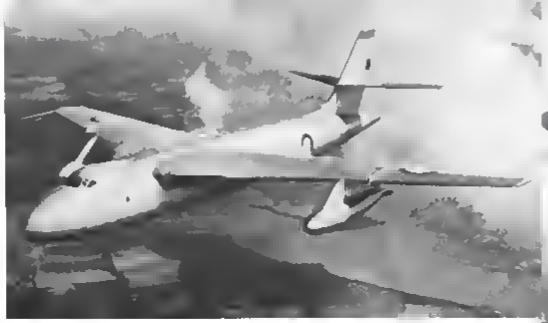
The Canadian Air Transport Board has for the time being ruled out helicopters for scheduled city-to-airport and intercity services.

▶**Airports**—A program of airport expansion has been announced for the next decade. It is to cover all major Canadian airports, and work is starting on the Montreal and Toronto airfields, which have the heaviest traffic.

New runways and terminals will be built at these two fields. The new terminals will allow passenger loading and unloading from ramps which go out to the parking aprons.

About $75 million is to be spent in all on airport modernization over the next few years throughout Canada.

HAWKER HUNTER

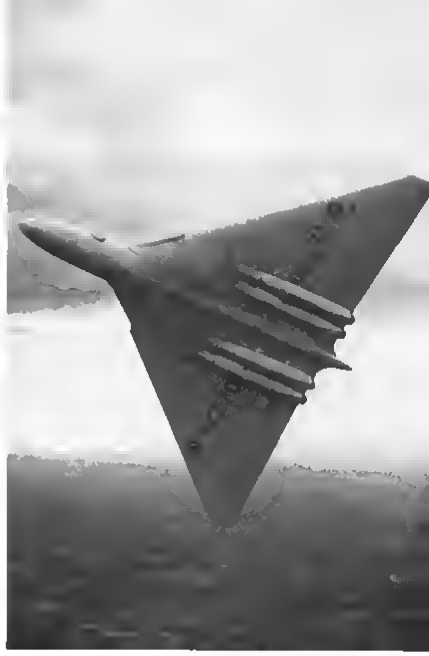


VICKERS VALIANT

FAIREY GANNET

DE HAVILLAND 110

FAIREY DELTA 2



AVRO VULCAN

● BRITAIN

British Airpower at the Turning Point?

By Seabrook Hull

(McGraw Hill World News)

London—At first glance, you might be tempted to sum up the last 12 months of British military aviation as "more of the same."

The skies still don't swarm with hundreds of Britain's latest and best. Production in many cases is still bogged down. U. S. aircraft remain the West's first line of air defense in Europe.

But under more careful inspection, you come to the conclusion that 1954 may have been a turning point in the postwar history of British airpower. Production of modern, high performance British aircraft as operational weapons may be about to begin, the floundering of the last 10 years, to end

Both industry and government are beginning to realize it is planes in squadron service now, today, that make airpower—not spectacular feats by prototypes on public display once a year at Farnborough.

Military, economic and political pressure is on to get planes in service before they're obsolete, to cut the gap between prototype and weapon.

▶ **Important Changes**—It's going to mean changes in procurement methods, policies, design emphasis and production patterns. Some are already obvious—more caution in placing large production orders; tougher attitudes towards industry when it doesn't come through.

Another move, important in the long term future of British aviation is the official abandonment of the balanced forces concept. Made clear in the 1954-55 budget messages, it follows a similar move in the U. S. some years earlier, when planning and budgetary emphasis shifted to the Air Force.

Hand in hand with this new policy is a developing long-term program of changing emphasis, and ultimately, perhaps, reorganization of the Royal Air Force. The pattern, in brief, over the next decade, is to build tactical airpower (interceptors) first, strategic forces later.

The light that's finally dawning in British aviation is simply this.

British aircraft fly or don't fly according to the same aerodynamic laws that keep latest U. S. designs in or out of the air. They're just as likely to suffer from tail flutter, wingtip stall, boundary-layer separation, de-oxygenated air, compressor blade stall, as their counterparts anywhere else in the world.

There's some evidence, even, that because of limited preflight research facilities, the liability of British prototypes to such troubles may be greater than in the U. S.

There's also an increasing tendency to admit that:

- There's no entrate way (either in money or time) to get the bugs out.
- You waste less money and time if you get bugs out before going into production, not after.
- You don't get much airpower "today" trying to jump too far, too fast into the future.

▶ **What's the Answer?**—The new determination to get British military aviation out of the uncomfortable situation it finds itself in today has yet to crystallize into a formal plan of action. The widespread criticism that began last fall both outside and inside the industry continues today. Nearly every Britisher—in pubs, clubs, taxicabs, board rooms, press and Parliament—has answers to the problem.

Whatever the final solution is, one thing seems certain. This time, there's some good hard thinking behind all the talk. Now, six years after the basic decision was made to rearm the West,

DH COMET 3

BRISTOL BRITANNIA

DH HERON 2

DH DOVE 6

10 years after the end of World War II, Britain has a couple of hundred modern fighters and less than a dozen strategic bombers in service That's not a very good record

By sifting through all that's been said on the subject, you can spot two facts Not only is the government tightening up and toughening up its procurement policies, but the industry, as well, is sobering up a bit The cynic might say it's growing up There's less boasting about what's going to happen "tomorrow," more concern with what hasn't happened to date

The political pressure is mounting for strong defensive airpower today. There's already some progress

The practice of promiscuously passing out large production orders based solely on one or two prototypes or a drawing board sketch has already been dropped. The first order for English Electric's new supersonic fighter—the P 1—was for two prototypes and 19 production aircraft That's quite a change from the Swift, Hunter, Supermarine 525, etc

The Scoreboard

You see the reason for all the furor when you make a quick spot check of British airpower today

In the closing days of 1954, the Hunter and Valiant officially began moving into squadron service In the last three months, the first production model of the Vulcan, making three all-told, has been rolled out of the erection hangar But rather than being a measure of productive might, it's merely something solid against which to measure the failure of the general effort to date

Here's where Britain's "latest and best" stand today

• **Hawker Hunter** Single Avon or Sapphire swept-wing interceptor over 600 mph , over 40,000 feet, dives supersonic. Class of F-86, MiG-15 First into squadron service at the end of 1954, three years after its classmates. Mounts four Aden 30-mm cannon plus drop tanks plus rockets Now apparently bug-free after curing oxygen starvation at wingroot air intakes and adding necessary divebrake Output over 60 a month from three U K and two Continental production lines Total orders, RAF and export, about 1,700 Ultimate RAF Hunter strength (based on current U K and U.S offshore orders), about 1,000

• **Vickers Supermarine Swift** Single Avon, sweptwing interceptor; near sonic, over 40,000 feet; dives supersonic Class of F 86, MiG-15 One squadron delivered last year Grounded Has suffered from oxygen starvation and compressor blade stalling in tight maneuvers Has broken up in flight due to control troubles (tail and other), still apparently unsolved Vickers was urged for over two years to install all-flying tail Final evaluation may decide it's fit only as advanced trainer or limited service fighter-bomber Some top RAF officials feel this contract should be canceled. About 400 aircraft are at stake

• **De Havilland D.H. 110.** Twin Avons, two-place, twin tailboom, slightly swept wing day and night fighter; near sonic; over 40,000 feet; first dove supersonic in 1952 Tail troubles cured with all-flying tail Structural weakness in booms and wing leading edge cured by beefing Necessary air brakes being fitted Has very good lowspeed characteristics for carrier work Has been ordered recently in volume for the Royal Navy This order should help DH compensate for Comet losses

EMPLOYMENT IN THE UNITED KINGDOM'S AIRCRAFT INDUSTRY

Employment in the "Manufacture and Repair of Aircraft" reached 237,300 at the end of October, an increase of 1,900 on the previous month.

	Males	Females	Total
1949			
June	130 700	21 300	152 000
December	131 900	22 300	153 200
1950			
June	128 000	21 500	149 000
December	131 300	22 300	153 600
1951			
January	134 100	23 600	157,100
February	135 900	23 400	159 300
March	137 000	23 600	160 600
April	138 000	23 900	161,900
May	137,240	24 350	161 600
June	138 600	24 300	162 400
July	139,600	24 700	164 300
August	141 100	25,100	166 200
September	143 000	25,500	168 500
October	145 900	26 700	172 500
November	147 100	27 000	174 300
December	149,000	27 300	176 500
1952			
January	151,000	27,400	178 400
February	154,000	28 400	184 100
March	157 700	28 800	186 500
April	159 800	29 300	189 100
May	163 870	29 780	193 600
June	164 300	29 900	195 200
July	166 000	30 000	197 000
August	167 900	30,500	198 400
September	169 500	30 700	200 500
October	171 000	30 900	202 000
November	172 500	30,700	203 200
December	173 500	30 700	204 000
1953			
January	175 100	31 000	206,100
February	175 700	31 000	207 400
March	178 000	31 400	209 200
April	179 000	31 700	211 300
May	181 400	32 000	213,100
June	183,000	32 100	215 700
July	186 900	32 000	218 300
August	185 000	32 400	218 300
September	188 000	32 700	221,000
October	191,000	33 100	224 100
November	193 000	33,600	226 200
December	194 100	33,200	227 300
1954			
January	192 700	33 500	229 200
February	196 700	33 800	230 800
March	197 400	33 800	231,300
April	197 700	33,700	231 400
May	197 900	33 900	231 700
June	197 400	33 500	231,300
July	198 200	33 500	231 700
August	199 600	33,700	233 400
September	201 400	34 000	235 400
October	203 100	34 200	237 300

Source: Ministry of Labor

• **English Electric P.1** Twin Sapphires, sweptwing interceptor, supersonic; over 50,000 feet, total thrust over 16,000 lb First flew last year and has topped Mach 1 repeatedly in straight and level flight. Orders placed for 21

• **Folland Gnat.** Single Orpheus sweptwing light interceptor; transonic; over 50,000 feet Designed by W E W Petter (of Canberra fame), Gnat is a private venture—no government money. First one flew last year with under-powered engine Prototype suffers from oxygen starvation when twin Aden guns fire Being cured Supply Ministry has shown little interest but Air Ministry may insist on an order, for maybe 12 to start Operational weight under 8,000 lb, it doubles well as a fighter-bomber Easy to produce and fly Was third after two French designs in Paris recommendations for standard NATO light fighter-bomber

• **Vickers Supermarine 525.** Twin Avons, sweptwing prototype in development of carrier based interceptor; near sonic; over 40,000 feet, dives supersonic Production order has been placed (probably for about 100) for as yet unbuilt aircraft to be developed from 525

• **Gloster Javelin.** Twin Sapphires delta-wing, all-weather interceptor, near sonic, near 45,000 feet, dives supersonic First production model completed last summer None in squadron service but still on schedule Did have tail flutter. May now be slightly overweight but expects better powerplant Present radar interceptor gear is U S-made and -supplied

• **English Electric Canberra** Twin Avons, two/three-place light bomber and high-altitude reconnaissance plane, over 600 mph; 45,000-to-50,000 feet, depending on mission Some 600 now in service. Excellent performance, but still some trouble finding proper role for it, since fighter-bombers have taken over World War II's light bomber missions But the B 8 is designed as a fighter-bomber Another mark is a night-intruder Widely used as engine testbed and in guided-missile research Now equips Strategic Bomber Command, due to unavailability of other types. Being made in U S and Australia under license

• **Vickers-Armstrongs Valiant.** Four Avons, cranked wing medium bomber; high subsonic; over 45,000 feet Class of B-47 First three delivered to the RAF at the end of 1954 Still suffers from undesirable tail vibrations under certain conditions Lacks trained crews, support facilities and necessary radar for longrange navigation and high-altitude "blind" bombing One squadron (11 aircraft) in service production about two a month

• **Avro Vulcan.** Four Sapphires or Olympuses, delta-wing medium bomber, "near Mach 1", over 50,000 feet Class of B-47/B-52 Carries load of B 52 but doesn't have the range Has flown at Mach 0.97 at 60,000 feet First production model has flown and will join two prototypes in carrying out handling and acceptance trials None in service A thin-wing version with podded engines is supposed to be under development

• **Handley Page Victor.** Four Sapphires, crescent wing medium bomber; high subsonic speed, over 45,000 feet. Class of B-47/B-52 Two made; one demolished after losing tail in low-altitude speed run High tail oscillates under certain conditions Thought of more as advanced aerodynamic testbed rather than as a near term potential atom bomber Payload of both Victor and Vulcan exceeds 70 tons

Statistically, British airpower is up from 1,000 planes in 1948 to over 5,000 today

What the statistics don't show is this The June 1955 RAF target was over 1,000 Swifts and Hunters in squadron service The actual total will be closer to 300 Hunters and no Swifts, plus 375 Canadian and 100 odd U S-supplied Sabres Except for the Canberras, everything else is out of date—Meteors, Venoms, Lancasters

Personnel in the RAF totals about 270,000

▶ **Weak in Transport**—Britain has virtually no military air transport command The massive air movement of heavily-armed ground troops is not part of Britain's military planning But for meeting local disturbances throughout the Commonwealth, a real effort is being made to build a very highspeed, fairly small transport service to supply more lightly-armed "commando-type" troops anywhere in the world.

With this object in view orders have been placed for the Vickers' 1,000, a four-jet transport powered by four Rolls-Royce Conway bypass engines The V 1,000 is supposed to be in the "over 600-mph cruising-speed" class RAF has placed an order for "a number" of Comet 2s

There's an order for 30 Blackburn Beverleys to handle heavy transport over short hauls

▶ **Weak in Bombers**—Britain's Strategic Bombing Command is now merely an administrative structure It has the organization, and the heads count up to a proper total. But it doesn't have the aircraft—you can't carry out high altitude intercontinental bombing missions in a Canberra

The crews aren't experienced—neither can you train in a Canberra, or a Lancaster either, for that matter

Longrange radar navigation, radar bombing, inflight refueling are essential to a strategic bomber force Necessary longrange navigation and high-altitude bombing radar isn't even in production yet

U. K. AERO EXPORTS*

Since the War	
Year	
1953	$182,013,690
1954	156,161,620**
1954 (by months)	
January	$14,963,580
February	14,871,500
March	15,509,770
April	13,795,390
May	12,416,260
June	11,648,410
July	15,324,010
August	11,147,850
September	9,983,990
October	10,996,860
November ..	9,690,750

*Includes complete aircraft, engines, airships, balloons and parts, electrical appliances for aircraft and rubber tires (outer covers).
** Annual rate based on first 11 months of year
(Source: Trade and Navigation Accounts of the U K.)

Much of the required logistical support doesn't exist Britain developed inflight refueling, but has no tanker squadrons or even a prototype on the way capable of servicing 600-mph bombers at 50,000 feet The idea of aerial mobility for fighting squadrons, either strategic or tactical, is little more than just that—an idea

That, in brief, is the picture of British airpower today It falls far short of British plans and world expectations The snag has been and still is in development Basic design in Britain is good But the ability to translate a flying machine into a fighting machine—a high performing platform for pilot, guns, radar, rockets, bombs—before the design is out of date, has been lacking

▶ **Constructive Approach**—Among the constructive criticisms aimed at the system are these, which are being given serious consideration by all concerned:

• **Give the Air Ministry** closer supervision over aircraft in development

• **Make greater use of U.S** knowhow, particularly in aerodynamics

• **Be willing to cancel** a contract if a project goes sour

• **Reduce the number of different new** types and put more effort into each

• **Lower sights** between each stage of development

• **Increase practical and theoretical research** One way or another you can count on greater emphasis being placed in each of these directions Precisely how these things are to be done remains to be seen—whether the Ministry of Aircraft Production will be recreated or more Air Ministry people assigned to the Ministry of Supply; how design and development planning will be charted in the future.

The current reluctance automatically to reward each new design idea with a production contract before the aircraft is proven is a step in the right direction A new willingness on the part of some British designers and builders to take full advantage of the best of U S aerodynamic and structural knowhow is evident and growing

▶ **Research Roadblocks**—In research, there's only one answer More money and more technicians Money is a matter of budgetary policy, but it seems certain that decisions have already been made to increase Britain's practical research facilities—wind tunnels (both low- and highspeed), structural test facilities Britain is still woefully short on wind tunnels

There's already a virtual "rush" to digital computers A V Roe is the first British airframe maker to order one, it's being installed now There's another in operation at the National Physical Laboratory at Teddington

The availability of trained manpower is a more difficult problem It's the same in Britain as it is in the U S , though perhaps more critical It can only be solved in time But as a stopgap measure, one suggestion is that some of the Ministry of Supply's large technical staff should be diverted to industry

Jet Engines

In jet engine development Britain is up with the best, if not slightly ahead Production is limited only by orders At least three pure jets of 15 000 lb thrust are running on test

• **De Havilland Gyron** has "supersonic" capabilities U S. Air Force officials describe it as "a very good engine"

• **Rolls-Royce** is running large experimental numbers of Conways (several different modifications) in test beds This bypass axial-flow gas turbine is supposed to have piston-engine fuel economy over long hauls Both the Gyron and the Conway are starting flight trials

• **Bristol Olympus 101**, with 11 000-lb thrust, is in production The Olympus 6 with over 15,000 lb thrust, after a little trouble to start with, is rolling up hours on the test stand

• **Bristol Orpheus**, light fighter engine, has a thrust of 5,000 lb and nearly a six-to-one thrust-to-weight ratio

Considerable effort is being concentrated on nuclear aircraft propulsion by Rolls Royce and English Electric, along with others

Radar

A weak point in British airpower is the lack of specialized airborne radar gear

When the aircraft do finally start

coming into service in volume, Britain should be able to fill her requirements with advanced models of most kinds of this material, however. For example, now going into production for installation in the Javelin is all weather radar interception gear for coordinating a blind attack using air to-air guided missiles.

Guided Missiles

Little or nothing is said about British guided missiles, except that "they're better than anything anyone else has." But none are in production.

First emphasis is on air-to-air rockets, second comes ground to-air. This ties in with Britain's susceptibility to sudden air attack. Almost every major airframe and engine manufacturer in Britain has a guided missile division and a Ministry of Supply contract.

The long-range course of British airpower as it's now being charted figures on achieving maximum tactical (interceptor) strength in 1957-58—"the time of greatest danger." After that plans are to rely more and more on ground-to-air missiles to stop any attack, and to begin building Britain's strategic counter striking strength with "V" bombers—first the Valiant, which should be in service in large numbers by then, followed and progressively replaced by the Vulcan.

There is a lot of talk that by 1965-66 there will be a single RAF Command, built around the Strategic Bomber Command. This would mean eventual elimination of the separate Fighter Command. After that, longrange guided missiles should begin to replace the bomber.

The Future

As in the U.S., a number of interesting developments are in the offing. Rolls-Royce has an operational prototype successor to its Flying Bedstead in advanced development.

One of the next prototype fighters will employ reverse camber in its wings (making them concave in part rather than convex as they are now), beginning the era of blown or suction ducted boundary layer control, with all its advantages of high lift, low drag.

Considerable interest has been generated among Britain's aviation industry in a littleknown field of propulsion, electro-gravitics, which may or may not lead to a revolution in flight.

If all this basic technical ability can now be backed up with practical applied ability to translate ideas in useful production models before they're obsolete, the next several years should see British airpower achieve its proper place in the world.

The postwar record so far is bad. The outlook, however, is good.

Britain Pushes Hard for Transport Lead

(McGraw Hill World News)

London—Civil aviation in Britain, despite the Comet's troubles, finds itself better off today than it was 12 months ago. Britain's bid for the jet airliner market has been knocked out of the skies by metal fatigue, and the age of the pure jet has been put back several years. To take its place, Britain has introduced the turboprop airliner to the world and passengers and airline operators alike have said, "We like it!" Prestige, sales and profits lost when the Comets were taken out of service have been more than made up by the Vickers-Armstrongs Viscount.

Britain is taking a share of the world's commercial airliner market that she never had before. She's cutting into the U. S. near-monopoly and, it would appear, stands a chance of making it stick.

▶**Turboprop Lead**—For the moment she is far ahead of her U. S. competitors in the development of turboprop airframes and engines. But the lead is being cut rapidly. The U. S. aircraft industry obviously was caught short on the turboprop, but now it's gearing its vast resources to catch up—and forge ahead—in a hurry.

The important thing, however, is that Britain is under no illusions. The advantage may be only momentary, but British industry is doing everything possible to establish its products firmly in world markets now. Transport manufacturers are working overtime to bring out the next mods and marks of higher, faster, longer-range and more economical turboprops, and turboprop development is already charted for the next decade.

▶**Comet's Future**—Whether the Comet will ever fly again in commercial service is far from certain. The modified Comet 2 will have about the same performance figures as the original aircraft.

Basically, the future of the Comet series—2 and 3—depends more on public relations, selling it back to the public and the operators, than it does on technical knowhow and market conditions.

The modified Comets will use 19-instead of 22-gage metal in the thinnest parts of the skin, wings are being heavily reinforced and oval windows are replacing square ones. Also there are to be modifications in refueling and aerodynamic control systems. Total weight increase as a result of these changes is 1,150 lb. But detailed airframe weight saving elsewhere offsets 550 lb. of this.

In addition, Rolls-Royce has promised a thrust increase from 7,050 to 7,350 lb. in each of the Comet 2's Avons, plus a lower specific fuel consumption.

More than half the 20-odd Comet 2s which were too near completion for economical modification will probably be bought as highspeed low-altitude transports for the RAF, thus helping to offset some of de Havilland's losses.

▶**V-1000 Transport**—Perhaps Britain's most important pure jet contender is the Vickers Armstrongs V-1000, boasting a thin swept wing with cranked leading edge (based on the Valiant wing) and four Rolls-Royce Conway bypass engines.

Due to make its first flight within 12 months, this aircraft has been ordered "in volume" by the Ministry of Supply as a military transport. It's due for RAF delivery in 1959-60. Vickers can begin supplying the airlines in 1960. As a trans Atlantic airliner, the V-1000 will be able to make the run nonstop in both directions under winter worst conditions at cruising speeds over 600 mph.

▶**Viscount Future**—Plans are in hand for development of the Viscount through 1960. Last modification will be built around a 2,000-eshp. Dart and may include a thin wing.

Finalization of designs for a successor to the Viscount is under way. It will be designed for longer stage lengths —1,500 miles maximum instead of the 1,000 miles for the Viscount. But it will not cut into the longrange market. No engine has been picked for this aircraft, although rumors say the R.B. 109 is the leading powerplant contenders.

▶**Britannia Orders**—Britan's bid for the longrange turboprop market is, of course, the Britannia. The first prototype and the first two production models are flying. Its entry into airline service has been set back by the new requirement that all pressurized airliners must undergo watertank fatigue tests. However, it is slated to go into service with BOAC near the end of this year. Once BOAC's order (and options) for 33 are completed, the Brittania will be available to other airlines in late 1956 or early 1957.

Bristol is not pushing the Britannia until it racks up an operating record in actual passenger-carrying service. Meanwhile, the company is pushing capacity at its own Filton plant to 25 a year and is working out a subcontract deal with Short Bros. in Belfast for another 25, if added capacity is needed for new orders.

The Britannia's growth and development is chartered through 1965. Plans are to culminate with a thin-winged, B.E. 25 powered version with nonstop capabilities across the Atlantic under winter worst conditions at over 500 mph.

▶**Powerplant Business**—Britain's engine makers are busy all around the world looking for markets.

The big fight at the moment is between the B.E. 25 (Bristol) the R.B. 109 (Rolls-Royce) and the Eland (Napiers). Both the B.E. 25 and the R.B. 109 are twin-spool engines. The B.E. 25 is constant power at 4,000 eshp to over 20,000 feet. The R.B. 109, also 4,000 eshp., loses power from takeoff but weighs less than the B.E. 25. Both are still pretty much "paper" engines.

The Eland is single spool 3,000/3,250-eshp. engine that weighs 1,500 lb. and is about to go into volume production.

The R.B. 109, so far, has no market. The Eland so far is slated only for the Fairey Rotodyne, and the B.E. 25 only for a future mark of the Britannia.

▶**Airline Business**—British European Airways rounded out its last reported year with capacity up, revenue ton-miles up and a 100% safety record. But the airline suffered a deficit as a result of its heavy reequipment program.

Aside from experiments with commercial helicopter operations, BEA has no major problems. The Viscount gives it an edge over its competitors.

BOAC, however, had its whole equipment program knocked askew by the failure of the Comet. Not only was the Comet withdrawn from service, but additional tests required on the Britannia, plus final development troubles on the aircraft, shoved the time when it was supposed to come into service back perhaps 12 months.

BOAC for the last six months has been trying to convince the government that it should have dollars to buy some "obsolete" U.S. piston airliners to fill the gap until new British equipment comes in—and to backstop its route system in case that equipment should develop troubles.

There's one drawback. British politicians tend to take a dim view of spending dollars when tomorrow"s British-made airliners are just around the corner.

Also, lately, the picture has been complicated by a reported offer by a U.S. financial group to lease Super Constellations to BOAC.

Neutrality Worries Swedish Military

(McGraw Hill World News)

Stockholm—According to official information from the Swedish Royal Air Force published in the daily press, Sweden's airpower now ranks fifth in the world. The RSAF ranks the first four as the Soviet Union, the United States, Great Britain and Red China, in order of size.

Sweden has 1,200 fighting planes and plans a 22% increase of this force in the near future. The question is raised whether this expansion alone will permit Sweden to hold fifth place.

Because of its solely defensive nature, the RSAF is able to make greatest use of each man, and from this standpoint RSAF is one of the most effective air forces in the world, Swedish sources say. Sweden's air force has 23 men per airplane, compared to 153 in England and 133 in the U S. The French force has 103 men per plane and the new West German force will have 60.

Sweden's contribution to Western airpower can scarcely be discussed without reference to the Swedish government's policy of neutrality.

Nor is it possible to obtain any proper picture of Sweden's military situation—including its air aspects—without considering what is happening in Norway and Denmark. As in the economics of air transport, in military matters the Scandinavian countries must be regarded as a unit. This has been emphasized over and over again by military spokesmen in all three countries.

► **A Likely Target**—In a recent report on the defense situation Gen. Nils Swedlund, Commander of the Swedish armed forces, emphasizes that it is impossible to tell what direction military operations would take in a third world war. But whether it starts with atomic bombing or not, it seems probable, he says, that the Russians would try to turn their superiority in ground forces and tactical air power to advantage by driving through Germany. Operations against Scandinavia would then, the report says cautiously, be "likely."

In Sweden, attention has been drawn, by Gen Swedlund and others, to the circumstance that as NATO strength grows, the likelihood of an attack aimed primarily at Sweden increases. Through their membership in NATO, the other Scandinavian countries have made arrangements to receive military aid if attacked. For Sweden, lack of such arrangements must mean aid will be slower in coming and less effective when it comes.

It is quite clear that Sweden cannot hold out alone for very long, and that it would be difficult to prevent parts of the country from being overrun. As things are now, it is an open question whether support could be given the other countries quick enough either.

Before joining NATO, Norway and Denmark had refused to discuss Swedish proposals for a Scandinavian neutral block, on the grounds that they could not arm adequately without American aid. Now the position is that they have accepted free arms and other assistance, but refused the corollary—the stationing of NATO forces in their countries, particularly at the airbases built for the common defense. Yet, as a Norwegian military spokesman has definitely stated, Norway at least does not have either the men or the resources to defend the whole country.

► **4,000 Daggers**—One can sympathize with the Scandinavians' attitude, even if one doubts its wisdom. Only recently a Norwegian newspaper published details of 400 Russian airbases—conveniently situated for bombing any part of Scandinavia—at which, it said, there are perhaps 4,000 modern aircraft stationed. Further, the Russians have 21 bases circling the Baltic with guided missiles trained on this area.

In the circumstances, the demand of the Swedish military that Sweden itself acquire atomic weapons is understandable. Both the Danish and Norwegian air establishments are still negligible factors, but Sweden's air force is getting to the stage where it could carry the attack to the enemy.

The Baltic is not too broad, and the new Lansen fighter, which is going primarily to the tactical wings, could carry a small atom bomb. Also, missile firing stations can be placed underground, in the good Swedish granite, as effectively as any other artillery.

► **Ten-Year Plan**—In the 10 year plan for Sweden's defense presented with the commander in chief's report at the end of last year, it is proposed gradually to increase the air force share of the defense budget from an average of 32% during 1950-55 to 37% in 1960-65. The army's share is envisaged as being correspondingly reduced from 41 to 34%, and the navy's from 20 to 17%.

It is emphasized that the cost of defense is bound to mount. The plan assumes, however, that the gross national product will continue to rise at a rate of 2½ to 3% a year, so that the defense outlay will still not exceed 5% of the national income.

For the air force, the big item of expenditure is of course equipment. In Sweden this accounts for no less than 66% of the total air appropriation. The commander in chief's plan would permit an 18% increase in the number of fighters, and 50% more tactical planes. Altogether, the increase in planes would be 22%. In addition, two of the fighter wings now equipped for day operations would be converted to all-weather wings—making a total of three such wings instead of one as at present.

Both the report and the commentary by the new air force chief, Gen Axel Ljungdahl, underscore observations previously made on the Swedish defense situation. Gen Ljungdahl says squarely that the dispersion of the likely bombing targets over a wide area, and the country's extended lines of communication mean that air defense needs are greater in Sweden than in many other countries. The proposed increase in fighter strength will not mean that more of the country can be defended—but simply that better defense can be provided for those parts which would be defended in any case.

The proposed increase in strength actually does not bring the air force up to what was considered the minimum even in 1948. Then the minimum was put at 13 day and three night fighter wings, all with a full complement of 75 planes. So far only six day fighter wings have been brought to full strength.

The new plan would give eight day and three all-weather wings at full strength. In other words, there would still be five fighter wings lacking. Some compensation for this lack is provided in the increase in tactical planes.

► **Budget Cut**—No trace of the commander's proposals can be found in this year's budget. The figure for the seven-year procurement plan under which the air force perpetually operates is even cut down from the proposed 3 323 million kronor ($665 million) to 3,107 million kronor ($622 million). The slash wipes out $17 million for development work, $16 million for fighter procurement, and $10 million for reconnaissance planes.

It means there will be no replacements for the Vampires and Swedish built S-18 reconnaissance planes which are scheduled to be withdrawn from service in a year or two.

Unless extra appropriations are forthcoming before 1957, too, Saab's production of Lansens may be interrupted.

► **Orders for Industry**—The air force's seven year procurement plan has been an excellent means of keeping Sweden's aircraft industry steadily and fully occupied. It is an economical method of working, and probably the only way out for a small country trying to go it alone. A possible disadvantage is that there is no slack to take up in an emergency, as the industry is already operating close to capacity.

The beneficiaries of the system are Saab, the country's sole aircraft manufacturer, and Svenska Flygmotor which makes British-designed jet engines.

Saab has expanded considerably in the last few years, adding manufacturing facilities at Trollhattan and Jonkoping (for components and accessories), and extending assembly space at the main plant at Linkoping. The company now employs some 6,000 persons, about 2,000 being engineers, draftsmen and office staff.

SAAB A-32 LANSENS

J-29 FLYING BARRELS

SAAB 210 'DOUBLE DELTA'

At Linkoping, J-29 Flying Barrels are still being turned out, and deliveries of the 750 mph all weather Lansens will start this year. The big event of 1955 will however be the first flight of the J 35, a 1,000 mph fighter designed from the start, like all Saab's military aircraft, in close collaboration with the air force. To fill the gap before this plane gets into production, the air force has ordered 140 Hawker Hunters.

Flygmotor is currently spending $4 million on an expansion program which includes an extension of its underground shop. Instead of trying to get all the 600 additional workers it needs, it is adding 200 or so to its present work force of 1,600, and contracting with Stal (turbine manufacturer) and Gevars Fiktoriet in Eskilstuna to supply parts. Production of Rolls Royce Avon 7 engines for the Lansen is underway at the Flygmotor plant in Trollhattan.

► **Bas Construction**—The airbase at Ronneby, S Sweden, has recently had its runway lengthened in readiness for the Lansens. In this year's budget there is a welcome raise in the appropriation for airfields from $5 to $6 million.

The commander-in-chief's report warned that construction expenditures on airfields, missile firing stations, fighter control and air watching headquarters—as well as in the rock naval installations—will have to rise considerably in the near future, however.

► **Military Research**—The general appropriation for military research that appears in the budget was also raised this year by $460,000 to $3 3 million.

This item represents only a small part of the total military expenditure on research, however. Of more interest was a special appropriation of $700,000 for development of a ground-to-air missile, with procurement authorizations running to $1.2 million.

The idea of atomic weapons is still not popular in Socialist government circles in Sweden. This attitude seems to be dictated as much by fear of irritating the Russians as by reluctance to shoulder the cost. Like neutrality itself, it deprives the armed forces of the means of putting up the most effective defense.

FINAL ASSEMBLY OF SAAB J-29S

SAS 'Monopoly' Faces Opposition

(McGraw Hill World News)

Stockholm—There is only one company really in the air transport picture in Scandinavia at present, and that is Scandinavian Airlines System.

It is generally accepted, too, that SAS will be the "chosen instrument" of Sweden, Norway and Denmark in international transportation.

But there are quite a number of candidates ready to compete with SAS for domestic business—whether "domestic" is taken to mean throughout the area, or within one particular country.

The countries of Europe are geographically so small, however, that it is difficult to keep to domestic and international traffic separate. The problem is further complicated when, as in Norway and Sweden, there are big areas where the population is sparse, distances are relatively great, and there are no large cities to provide any volume of traffic locally.

► **Trouble in Northland**—Paradoxically, too, SAS' claim to a monopoly of Scandinavian air transport is running counter to efforts to achieve economic integration of the area generally. The Scandinavians themselves seldom even use the term Scandinavia—in their thinking the unit is "the North," which includes both Finland and Iceland as well as the three Scandinavian countries proper.

Now Iceland is a member of the Nordic Council, which has been set up to coordinate the steps towards integration, but Finland is not. Yet there is a very smooth working arrangement between the Finnish Aero line and SAS—while the Icelanders are threatening to leave the Council on account of pressure being applied through the Swedish government to check an Icelandic airline's competition with SAS for the trans-Atlantic business. There is a considerable segment of opinion in Norway, too, favoring greater freedom for independent airline operators.

► **Room for More?**—Still, it is unlikely that any of the three countries will feel that it can afford to let SAS fall apart. If they want to have an airline of SAS' calibre, it seems they have no alternative but to have it together. The 'dead end" geographical position of Scandinavia, combined with the countries' small populations, provides powerful argument for a single carrier. The question is just whether SAS needs a complete monopoly, or whether there is room for others too.

► **The Competition**—Among those eager to offer competition are the Norwegian shipowners Ludwig Braathen and the Fred Olsen Line. With his SAFE operation, Braathen opened up the Far Eastern route from Scandinavia, and made it pay. But his 5-year concession ended last year, and the Norwegian government did not renew it. Now SAS has the field to itself there too.

By reducing prices and still providing good service, Braathen also made the short Oslo Stavanger run pay—a route which SAS said needed a subsidy. Last year Braathen's passengers increased from 16,000 to 24,000, and the number is still going up. A private Danish proposal that Braathen should expand into Denmark, where domestic services have been maintained only fitfully, received no encouragement from the Danish authorities, however.

Similarly, Fred Olsen has given up trying for concession for the routes Oslo-Bergen, Oslo Amsterdam, and Bergen-Newcastle. SAS has informed Olsen Line that it is not interested in collaboration—although it maintains joint services with smaller companies in West and North Norway and in Sweden. On account of public opinion, however, the Norwegian government has been extremely hesitant in taking a definite standpoint in regard to independent domestic air services. Consequently there is a general state of uncertainty throughout Scandinavia—as in so many other fields where integration is being discussed.

► **Domestic Bid**—A proposal for taking over the domestic services in Sweden has come from a 20 year-old company, Svensk Flygtjanst. Flygtjanst spokesmen point out that important manufacturing centers like Norrkoping, Karlstad, Orebro, Sundsvall, have no regular air services. They also say that with only one flight a day connecting Gothenburg, Malmo and Lulea (in the far north) with the capital, it is often just as quick to take the train. Flygtjanst carried passengers before the war, but has since been doing only target towing for the air force, for which it has 26 planes. It is now buying three DC-3s and a DC 4 for charter services.

NORTH NORWAY GUIDEPOST

Flygtjanst people also put forward the argument that with a single organization for Scandinavian services, the cost of the operation will never be reflected in the ticket price. Profitable Swedish routes, they say, will have to subsidize unprofitable Norwegian ones. At present, only the North Norway services are really subsidized, the Norwegian government paying SAS 1.4 million Norwegian kroner ($200,000) to maintain them. But then, SAS does not maintain services on other routes which it says are unprofitable—and which Flygtjanst is proposing to fly.

► **Iceland and Finland**—In the discussion of domestic services, Finland and Iceland are often brought up as examples.

Although the population of Iceland is only 160,000, last year the local airline Flugfelag Islands carried 52,000 passengers, 28% more than in 1953. Of this number, 46,480 were carried on the line's 23 purely domestic routes.

Flugfelag Islands pays its stockholders a 4% dividend, too.

When more frequent local services were provided in Finland last year, passenger traffic shot up there too. But Finland has poor railway services and bad roads. Both highways and railroads have to take circuitous routes on account of the numerous lakes. And Iceland has few roads and no railways. It is noticeable, too, that both the Finnish and Icelandic companies tend to extend their network outwards, towards the big centers of population in Europe.

Finnair Aero Oy runs services with Convair 340s through Scandinavia and Germany to Paris, under a five year pooling agreement with SAS. The line has three Convairs, with nine DC-3s for domestic operations. Flugfelag Islands operates routes from Reykjavik both to London and Copenhagen with DC-4s. This summer it will have three flights a week to Copenhagen instead of two.

► **Loftleidir Slashes Fares**—It is the activities of the other Icelandic airline, Loftleidir, which are assumed to be back of Sweden's denouncing its air treaty with Iceland. This line has been carrying passengers between Scandinavia and New York, via Reykjavik, for $60 less than SAS charges for the tourist-class one-way trip. Now Loftleidir is going to make the difference $145, and will increase flights this summer from three to at least four or five a week.

The Icelanders operate their Atlantic service with three DC 4s—one of which is chartered from Braathen. They also use Braathen's maintenance facilities at Sola in Norway. But Swedish charges that Loftleidir is controlled by Braathen have brought indignant protests from the Icelandic legation in Stockholm.

Loftleidir has created the route by neatly combining two concessions, Hamburg-Reykjavik and Reykjavik-New York. The latter includes no stipulations about IATA rates, and it is on the New York-Reykjavik leg that the price difference occurs. The airline says it can offer low rates because it fills up unoccupied passenger space with cargo. Among the ironies of the situation are these aspects. Braathen's DC 4 became available because his Far East concession has been stopped—and SAS dropped the Reykjavik route from its network because it didn't pay.

► **The Big Ships**—Apart from Braathen's and Fred Olsen's DC-4s, all the big transports in Scandinavia belong to SAS. Most of the DC 3s are owned by SAS and Aero Oy. In Sweden there are about 300 aircraft with valid certificates, in addition to SAS planes. These are mostly small craft of the taxi type, a great number of different manufacturers being represented. There is a similar plethora of makes in Norway, too, used in taxi, charter and scheduled services.

Eagerly awaited is the arrival of eight Douglas DC-7Cs ordered by SAS. This plane will not only make possible direct flights from Copenhagen to New York, but will enable SAS to skip Greenland on its Los Angeles run. Still more, it will clip a whole 24 hours off the Tokyo flight, which will be made in two hops—from Bodo in North Norway to Fairbanks, and from there to Tokyo.

► **In the Beginning**—When SAS started as the chosen instrument on the Atlantic routes, in Europe the national airlines continued to compete as before. But the arrangement didn't work, there were heavy losses, and the Norwegians were ready to pull out.

The present setup, with the national companies operating through a single organization, dates from 1951. At no time during the first four years has it been necessary to draw on the guarantee against an operating deficit given by each Scandinavian government to its airline. Since 1948, when the first steps were taken towards fusion of operations, capacity has increased from 69 to 203 million metric ton-kilometers a year, while the total number of persons on the payroll has been reduced from 7,500 to 7,200.

► **SAS Routes**—The airline now serves 73 cities in 37 different countries. The total network is about 125,000 kilometers. SAS gets about 60% of its business on the intercontinental routes—to North and South America, Africa, and the Far East. Barely 3% of the European share derives from Scandinavian domestic traffic. And about three quarters of the company's income is in non-Scandinavian money.

► **Tourist Class**—Although tourist class was a big success for SAS on the North Atlantic route—where it was largely responsible for a 56% increase in the number of passengers carried in 1953—it did not pay in Europe. There a 12% increase in capacity brought SAS only 5% more sales.

The price reduction of 20% was not enough to attract much new business, and the reduction in amenities annoyed old customers. Scandinavian businessmen prefer to travel in comfort.

So SAS now has relatively few all-tourist flights, a good number with first class only, and most with both first class and tourist.

► **SAS Fleet**—All the intercontinental routes are flown with DC-6Bs or DC 6s, of which SAS has 14 and 12 respectively. These planes are also used exclusively on the London and Paris runs. Lesser European routes are served by 4 DC-4s, 10 DC 3s, and 8 Scandias. Two old Junkers Ju-52 seaplanes are still used in North Norway between Bodo and Kirkenes.

Servicing is split among the three countries—the shops in Stockholm taking the DC-6s, Copenhagen the DC 4s, and Oslo the two-engine Scandias and DC-3s.

SAS reputation for high class maintenance has landed the Danish shop at Kastrup airport some nice business in servicing planes for other airlines, such as India Airlines, Saudi Arabian and Greek lines, and the U.S. Air Force.

Recently the Colombian airline, Avianca, contracted for overhaul of six DC-4s here at a cost of 5 million kroner ($700,000). SAS has 2,100 workers in its shops, 650 of them at Kastrup.

Flight personnel comprises 13-14% of SAS total employment. There are 395 pilots, 160 navigators, 140 flight engineers, 190 pursers and stewards, and 190 stewardesses.

► **Organizational Troubles**—The clause in the SAS agreement giving Norway and Denmark each the right to two-sevenths of the employe total, and Sweden three-sevenths, has proved a latent source of trouble. All the Swedish co-pilots, 68 altogether, have recently given notice that they will quit, in protest against the promotion of Danes with much less seniority. Denmark had few trained pilots when SAS started, but their numbers have grown as the Danish air force developed, and many have since gone over to the airline.

—G. Howard Smith

German 'Airpower' Today: Plans Only

By Gerald W. Schroder
(McGraw Hill World News)

Bonn—No precise facts and figures have thus far been released on the new German air force—the Luftstreitkraefte. Two factors have become rather obvious, however, over the past few months:

First, the Germans will not be satisfied with anything less than the most modern, proven and effective material. They can be expected to put up a scrap if other NATO nations should feel inclined to furnish them with second-rate or obsolete aircraft.

Second, the Germans are going to concentrate their efforts on building a powerful, hard-hitting fighter organization.

Under the now detuned EDC treaties the Germans were to establish 10 fighter-bomber squadrons and six fighter squadrons.

It is now reported in aviation circles in Bonn that this ratio has been reversed. In all probability the Germans will set up 10 fighter squadrons and six fighter bomber squadrons.

Air Force Plans

Although the Dienststelle Blank, the office of the West German government charged with rearming Germany, refuses to disclose actual plans for the new Luftwaffe, it is more than probable that the German air force will have the following composition:

- **Eight fighter squadrons** of 75 planes each. The Germans are thinking of Hawker Hunter planes for these squadrons, if Hunters are not available at the right time, they will think in terms of Sabre jets.
- **Two all weather fighter squadrons** of 36 planes each. The Germans are thinking of F-89s for these squadrons.
- **Two reconnaissance squadrons** of 54 planes each, F-86 K's are being considered.
- **Two transport squadrons** of 48 planes each, no decision has been made as to type of plane.
- **Six fighter-bomber squadrons** of 75 planes each, probable type F-84F.

Planning for the new German air force is in the hands of Werner Panitzki and his staff. Panitzki, 43, joined the German army in 1929, then switched to the Luftwaffe in 1935. He has been with the Blank Office since 1952 and has devoted his time to air force matters.

▶**Personnel Problem**—One of the greatest problems facing the new German air force is that of personnel. Over 2,000 pilots will be needed, most of them between the ages of 35 and 40. It is estimated that the total air force, including anti-aircraft units to protect installations, might number as high as 100,000 men. The Germans will face tremendous difficulties training this number of semi- and fully skilled specialists. Most of those available have been out of aviation for over ten years.

Volunteer pilots will probably have to sign up for six years, technical personnel for four years. Pilots, especially former Luftwaffe pilots, will receive their jet training outside Germany, they will also have to study English, NATO's official language. Their flight training will take an estimated eight months.

No one at this point knows how the Germans are going to get the necessary planes. Since Germany's aviation industry has not yet resumed operations and the Germans are not allowed to build certain types of planes until final ratification of the Paris treaties, they will be forced to import almost all of the aircraft needed for the new air force. It is highly likely that they will receive their planes under some sort of lend-lease assistance or outright grant from the United States.

▶**Selecting the Brass**—It is not known at this time who will command the new German air force. All ranks from colonel upwards are to be approved by a civilian "personnel committee" which has as yet not been appointed. The committee will consist of judges, members of parliament, industrialists and others prominent in public life.

One possible commander, mentioned frequently in recent weeks, is ex-Lt.Gen. Adolf Galland, former Luftwaffe ace, who returned to Germany from Argentina during the first week of January.

Aircraft Industry

▶**Needs Military Orders**—One outstanding factor is beginning to emerge in German thinking. There will be no rebirth of a large, effective German aviation industry without military orders.

This is one of the reasons why industry officials are closely following the current negotiations for a Western European armament pool. The outcome of these discussions will decide what, if anything, is to be built in West Germany for NATO defense forces, including the new West German air force.

The recent Paris agreements, now awaiting final ratification, provide that Germany will build no atomic, bacteriological or chemical warfare weapons, no long-range strategic bombers, no guided missiles and no fighting ships over a certain tonnage.

Military and civil liaison, training and sport helicopters, and transport planes may be built freely, without supervision by NATO arms commissions or any other agency. But it is the "in-between" field of military aviation equipment, which could be built under close NATO supervision and control, that holds promise.

▶**African Pool**—Although generally interested in a West European arms pool, the Germans are still cool to the idea of establishing a joint French-German aviation industry in North Africa.

They see the advantages of an African location from a strategic point of view, but they point out that only 20% of the actual work of constructing planes, primarily the final assembly, would take place in Africa, the other 80%, primarily the building of parts and accessories, would still have to take place in France and Germany. It would, to the Germans, be highly impractical to have to ship all the materials, parts, accessories to Africa for final assembly only.

Another point the Germans stress is that they would only be willing to join a French-German aviation industry in Africa if they can enjoy a position of "relative equality" with the French industry as regards a domestic German aircraft industry.

In other words, the Germans will insist on building their own aviation industry at home before showing any willingness to send money, materials or men to Africa as part of a joint French-German industrial effort.

▶**"Pure Moonshine"?**—Several well-informed aviation experts, when asked about future possibilities and plans of the German aviation industry, have replied simply by saying "It's all pure moonshine."

These observers point out the following—to them practically insurmountable, deficiencies and obstacles:

- **The industry has no money**, but still has sizable debts. The industry's financial position is an odd one.

The former German Reich still owes the industry about 800 million Reichsmark for orders and deliveries executed during the Hitler regime and World War II. The Reich's successor, the present West German government, shows no inclination to assume these debts and pay the companies involved.

At the same time, the industry still owes about 500 million Reichsmarks to German banks, this money was borrowed during the same period in order to finance the Reich's military orders. The German banks today still lay claim to these debts and have shown themselves unwilling to strike them from the books.

It is obvious that before any real start can be made by the industry this tangled skein of debts and counter-debts will have to be settled by governmental legislative action.

- **The industry has no plant capacity** of any size at this time. True, there are a few empty sheds, halls and hangars in existence, but these would provide a basis for the most modest start only.
- **During the past 10 years** the Germans have been forbidden to work in aviation. As a consequence many observers point out, there is a tremendous deficiency of trained designers, engineers, procurement and inspection personnel.

If the Germans are to catch up in this field large numbers of young men will have to spend years abroad to close the gap in knowledge that opened up since the last war. In the U.S. alone, the sums spent by industry and government on research are many times as great as the total sum the Germans could raise to start a new aviation industry.

- **While the auxiliary industry**—companies making tires, instruments, batteries, etc.—are in excellent shape, it is doubtful if they would be interested in retooling to meet the rather limited demand for their products from a German industry. For the industry itself it might be cheaper during the first few years of growth to import many of these items.
- **The new air force will be a potent** competitor for large numbers of men, most of them now in their thirties and early forties, who have a basic grounding in aviation.

Representatives of the industry itself fully acknowledge the difficulties that face them. They realize that the days when you could produce a prototype model in a backyard hangar with half a dozen mechanics and engineers and on a shoestring are definitely over. Even men who a short two years ago spoke in glowing terms of the tremendous opportunities facing a reborn German aviation industry have apparently had sobering second thoughts.

▶**What May Be Done**—The concrete possibilities for a new aviation industry now fall into these categories:

- **Establishment of small plants** to do repair work for NATO forces stationed in West Germany, including the new German air force. This would call for relatively small outlay of capital and might provide a basis for future independent work. It would also give the industry a chance to acquaint itself with different types of new planes.
- **German industry might start**, as soon as possible, the production of standard parts for foreign customers. The Germans believe that they could get into this field of production within a very short time and thus help alleviate what they believe to be a current "shortage" situation.
- **Start building complete planes** under license from the United States and Britain. There have been reports that the Germans have been approached by several large American corporations in this respect. The Germans point out that they could produce planes, under license, for export to areas that are now short of dollars, such as the Near and Far East.
- **Production of training, liaison** and "executive" transport planes, and helicopters, now seems attractive and possible to the majority of German builders. But these men say even in this field a realistic start would be extremely difficult without sizable military and export orders.

Professor Heinkel is rumored to be working on a revolutionary type of new helicopter and the Deutsche Studiengemeinschaft fuer Hubschrauber (German Study Association for Helicopters) in Stuttgart is reported very active in the same field. Understandably, the Germans are not talking about what they have up their sleeve in new designs and models.

▶**Government Support**—Financing of any kind of sizable reconstruction program will remain the bugaboo of the industry for years to come. There is growing pressure and demands that the German government establish a system of "paragraph 7d" funds, similar to the incentives granted the German housing and shipbuilding industries.

Under paragraph 7d of the German tax system, any funds invested by individuals, banks or corporations may, within limits, be exempted from income tax during the year they are invested in these industries. As these investments flow back to their investor they are, of course, taxed, but since German income and corporate taxes are on a downward trend, this "displacement of taxable income" into future years, when taxes may be lower than they are now, has held great attraction for many German investors.

It is more than probable that the German aviation industry is overly optimistic regarding its chances for an equal break with the shipbuilding and housing industries. The 7d system is being abolished this year.

The industry is also hopeful that individual builders may be advanced public or private money to construct production facilities after they receive military orders. This seems like putting the cart before the horse since it is hard to see how they will receive orders of any kind in the first place without adequate production facilities and with average to poor credit ratings.

Most realistic of German builders appears to be Prof. Heinkel, who recently declared that the German industry "couldn't even begin to think of anything beyond the construction of parts and planes under foreign license, the construction of small training and sport planes and helicopters."

▶**Leading the Pack**—Among the companies most likely to enter the field after final ratification of the Paris treaties are Heinkel, Dornier, Messerschmitt, Weser Flug A. G., Junkers, Daimler-Benz, Henschel, Focke-Wulf and Bayerische Motoren Werke (BMW).

Most of these firms belong to the Aero-Union, a loose organization of companies interested in getting back into aircraft production. They also belong to the Association for the Promotion of the Aircraft Industry in Duesseldorf. This association plans to change its name in the near future to Federal Association of the Aircraft Industry.

While the Germans certainly hope to develop their own designs in time, initial orientation will certainly be toward the United States and Great Britain. Eventual licensing agreements would certainly be made primarily with U.S. companies but the Germans also display a lively interest in turboprop designs and will continue to follow British developments closely.

Timetables for the reconstruction of the industry vary tremendously. It would appear reasonable, however, to assume that light training and sport planes as well as helicopters may be airborne within 18 months to two years after the industry gets the green light. Estimates for the production of larger transport planes range from three to seven years.

In time of emerse, the Germans hope that their own airline Lufthansa, will fly planes of German design. But even the most sanguine of experts does not expect to see this happen within the next eight to 10 years.

● GERMANY

Lufthansa Set for Atlantic Flights

(McGraw Hill World News)

Bonn—Unless unforeseen delays in the final ratification of the Paris and London treaties crop up, the new German Lufthansa plans to resume service on several routes in April.

The initial runs of the German airline will be

- Daily flights from Hamburg Duesseldorf to London, and from Munich-Frankfurt to London
- Three times-a-week flights from Hamburg-Frankfurt to Paris, pool arrangement with Air France.
- Twice weekly flights from Hamburg-Cologne Frankfurt to Madrid, pool arrangements with Iberia

Four Convair 340s will be used on these routes British pilots will be used as captains, with German nationals understudying as co-pilots for at least the first full year of passenger-carrying operations

▶ **Overseas Routes**—As soon as Lockheed's four Super Constellations are received, Lufthansa plans three flights a week from Hamburg Duesseldorf to New York and three flights a week from Hamburg Frankfurt to New York, thus, Lufthansa hopes to establish daily service on its Germany New York run this summer

Then, when the additional four Super Connies, ordered in December 1954, are received, service to South America will be started and, possibly, service to New York will also be intensified

As Lufthansa's fleet of planes increases, service to Africa, the Near and Far East will be initiated

▶ **Money Troubles**—Lufthansa, originally capitalized at 25 million Deutsch mark ($6 million) raised its capitalization to $12 million last fall. This figure will probably have to be raised to $20 million before the "initial reconstruction stage" is passed

While Lufthansa officials have been hopeful that private industry would join in underwriting their new venture, private capital has been extremely slow in forthcoming. At present, the line is capitalized up to 90% by the federal government and the states, with only 10% coming from private sources This situation is causing a certain amount of uneasiness in Lufthansa circles, officials claim that "once our planes are in the air industry will show its faith in us and start investing."

At the same time, there are increasing reports that certain segments of German industry are dissatisfied with the present Lufthansa management and are unwilling to invest sizable sums before the management structure is completely overhauled.

▶ **U.S. Gets the Order**—Competition between U S and British firms for Lufthansa orders will remain stiff Lufthansa is aiming at a 40 plane fleet and it is highly improbable that a reborn German aviation industry will be able to produce suitable transport planes for years to come

The British appear to have lost Round One when Lufthansa ordered Convair 340s and Super Constellations But the Germans are taking a close look at the Vickers Viscount and no one in Germany would be surprised if Viscounts were ordered this year for the expansion of Lufthansa's medium-range routes

▶ **BOAC Agreement**—In addition, Lufthansa has signed an agreement with BOAC which calls for

1. BOAC sponsorship of Lufthansa for admittance to IATA and other international aviation associations.
2. BOAC aid of technical and financial experience with British aircraft. Advice and assistance to Lufthansa when dealing with British aviation companies.
3. Training by BOAC, of Lufthansa personnel at cost
4. Interline traffic, baggage and cargo agreements to be considered between both partners
5. Partners will work together towards pool arrangements on mutually agreed routes, thereby establishing a coordination of schedules once the German partner is in operation and is member of IATA If Lufthansa is not ready to take up its share of any routes on which it has or can obtain rights, BOAC will be given first opportunity to take over the routes until Lufthansa is ready to operate them itself Commercial desirability, schedules and financial arrangements for each individual route to be operated on behalf of Lufthansa are to be decided mutually by BOAC and Lufthansa If they fail to reach agreement, Lufthansa will be free to negotiate with other operators

Paragraph 5 has caused a certain amount of stir in aviation circles both in Germany and abroad Lufthansa officials are quick to point out, however, that the first four paragraphs of this agreement are innocuous and Paragraph 5 will in all probability never be enforced

No one in German aviation circles is happy with this agreement, and reports that the agreement was signed under "political pressure" coming from both Britain and the German Transport Ministry appear more than well founded

SNCASE BAROUDEUR

SFECMAS GERFAUT

● FRANCE

French Air Force Upgrades Quality

By John Coppock

(McGraw Hill World News)

Paris—The year 1954 can be characterized as one of quality improvement for the French Air Force, according to military observers here.

Though the number of combat-worthy planes did not increase greatly, units were better equipped and better trained. The quality improvement, together with a limited expansion in numbers, will apparently continue steadily during the coming two years.

▶ **Industry Unhappy**—But if military men are reasonably satisfied, French plane builders are not The year passed with few new military orders placed, and the outlook for 1955 is not bright

Although the new military budget has not been disclosed in detail, it is obvious from its total figures that funds for aircraft construction will be extremely limited Further, French hopes for additional offshore procurement contracts under the U S Mutual Defense Assistance Program are not particularly bright

Despite the existence of half a dozen prototypes, technical aircraft men say French builders do not have a model ready to go which would warrant substantial new production contracts The most promising item for the future is the Breguet Taon, a lightweight fighter still on the drawing boards

▶ **Military Deliveries**—During 1954, the FAF received the last of a series production of 350 Dassault Ouragan fighters (M D 450), which were put in service mainly as replacements for the Mistral, a French version of the British Vampire The FAF also received an unspecified number of F-84Gs under the MDAP agreement with the U S, which are replacing existing F-84s.

Also, the FAF took delivery of the first 15 of a series of 150 Dassault Mystere 2C fighters, and received a squadron of Meteor nightfighters from Great Britain.

These combat aircraft, together with 50 Nord 2501 transports, constitute the overall deliveries to the French Air Force last year, apart from training planes.

▶ **Yet to Come**—Scheduled for delivery in 1955 and 1956 are the remaining 135 Mystere 2Cs, and a total of about 400 of the Dassault Mystere 4 group—4As equipped with a Hispano Suiza Verdon engine of 7,700 lb thrust, 4Bs powered by a French built version of the Rolls-Royce Avon developing 9,900 lb thrust with afterburner, and 4Ns which will be nightfighter versions

LEDUC R.21

SNCASO VAUTOUR

Also to be provided in the immediate future are 70 Vautours (S.O.-4050), being built in three versions—all-weather fighter, ground support, and light bomber—all powered with Snecma Atar 101 engines of 6,600 lb. thrust each. Substantial follow-on orders are expected for the Vautour.

A hundred Fouga Magister trainers (C.M. 170R), equipped with two Turbomeca Marbore 2 engines of 880 lb. thrust each, are also scheduled for early delivery, and 60 to 80 more Nord 2501 transports will be handed over to the FAF.

▶**Prototype Prospects**—With prospective construction funds substantially encumbered by the present program and little prospect of larger budgets for the future, French builders find themselves with several interesting military prototypes unlikely to be contracted for.

• **The S.E.-5000 Baroudeur** has perhaps the best chance of winning a place for itself. Now equipped with a Snecma Atar 101 engine of 7,260 lb. thrust, it has an official speed of 650 mph. at 20,000 ft., but is known to have flown considerably faster in trials. The Baroudeur employs a rocket-assisted take-off from a dolly, and has been tested on a wide range of rough terrain and short strips. It lands on skids.

• **The SO-9000 Trident** is an experimental fighter powered by a three rocket motor supplemented by two Morbore jet engines. Its performance and specifications have never been made public, but it is thought to have reached supersonic speed in its first trials with the rocket motor last September. The prototype is now being modified to use two Armstrong Siddley Viper engines of 1,760 lb. thrust in place of the Turbomeca engines.

• **The Sfecmas 1402 Gerfaut,** an experimental fighter equipped with a Snecma Atar engine, exceeded Mach 1 in level flight last August. No details have been released on the specifications of the Gerfaut. It is France's first delta-wing attempt. Likewise, experiments continue with France's first ram-jet, the Leduc 0.21, which was launched in the air for its first flight in August 1953.

Despite these developments, it is generally conceded in Paris that French aircraft producers are due for a substantial shakeout during the next few years. Military demand, limited by a national budget always in deficit, is unlikely to exceed more than 500 planes per year of all types. And so far French transports have not caught on in the world market to any appreciable extent.

At home, Air France has maintained a steady complaint against the government policy which has forced it to buy French-built commercial aircraft which are high cost, mainly due to the fact their series production has never been great enough to reduce unit prices.

It is widely believed that 1955 and 1956 will see considerable consolidation of the French aircraft industry, which is already two-thirds government-owned. It is known that Louis Breguet, for one, is deeply in debt to the government after the virtual failure of the Model 763 Deux Ponts to find buyers. Observers expect SNCASE to take the firm over.

Other private firms may find themselves in similar difficulties unless some miracle injects new life into the business. Few observers are depending on it.

DASSAULT MYSTERE 4N

HUREL-DUBOIS 31 & 32

Gloomy Year Ends for Civil Air

(McGraw Hill World News)

Paris—The year 1954 was a relatively unhappy one for French civil aviation—both for the aircraft construction industry and the airlines.

Air France's loss for the year, expected to total about 3.5 billion francs ($10 million) when accounts are published, led the list of last year's developments which are giving the French industry cause for serious thought.

Only one commercial plane, the already outmoded Noratlas (Nord 2501), was in series production at the end of the year, with no prospect of follow-on orders when the present run of 140 is completed this year.

▶**One Bright Spot**—The single bright spot in the construction industry's picture for the near future is the favorable reception given to the H.D. 32, Hurel-Dubois' twin-engine, 44-passenger transport.

Backed by orders from Air France and with good prospects for foreign sales, the H.D. 32 will go into series production in 1955 with deliveries starting in 1956. It will be produced by Sncase (Societe Nationale de Constructions Aeronautiques du Sud-Est), a government-owned company, whose four-engine Armagnac has been dropped after a production of eight aircraft.

Commercial air traffic in France increased substantially in 1954. Passenger movements through Paris Airport (Orly and Le Bourget) reached 1,748,322 for the year, an increase of 13% over 1953. Freight increased by 11.2% and postal movements by 16.9%.

Air France

Air France's financial loss for the year attracted most attention in Paris as 1954 ended. Analysis of the factors going into the loss has led observers to believe that Air France is in for a long period of reorganization before it can get out of the red.

While the company points out that much of its difficulty arises from reduced load factors on many of its scheduled runs, independent critics point out that Air France generally is utilizing its capacity at better rates than other airlines currently showing a profit.

▶**High Cost of Money**—Other factors emphasized by company president Max Hymans are of a type which it will take some time to overcome.

High capital charges are a major burden, according to Hymans, interest payments and capital amortization outlays in 1955 will total $12.6 million. With a far-from modern fleet, damaged by the grounding of its Comet 1s and with little opportunity to obtain equity capital in the face of past and prospective losses, Air France will probably have to continue to depend on high-cost, short-and medium-term loans, which will mean several years of high capital charges against current revenues.

Air France has already begun a policy of retrenchment. In early January it dropped its twice-weekly Paris-Manchester run, said to be the first of a series of such actions to reduce its unprofitable schedules.

As a result of new legislation, negotiations between Air France and the French government have begun which should end in new contracts covering certain operations. The company has long contended that certain "prestige routes" insisted on by the government have resulted in financial losses which the government should meet.

In all probability, however, such new arrangements are unlikely to provide Air France with more than 53 million in new revenues and savings during the next year.

▶**New Equipment**—When Air France puts the H.D. 32 into service, presumably in 1956, it may have a money-making addition to its equipment.

Designed to operate from short landing strips, even grass, the H.D. 32 will meet a need for an aircraft operating on the largely neglected domestic routes in France and on short international hauls.

Transport Aircraft

The H.D. 32 will be manufactured by Societe Nationale de Constructions Aeronautique du Sud-Est under an agreement with Hurel-Dubois announced in January. Sncase is counting on series production of 150 aircraft of this type (or a slight variation called the H.D. 321 which will use two Wright R1820 engines), to be sold at a price of 145 million francs ($414,000 at current exchange rates). Air France has contracted for 24 of these planes.

▶**Noratlas**—In an effort to resuscitate interest in the Noratlas (Nord 2501) tests have been made recently by Sncan for adding two Turbomeca Marbore 2 jet engines at the wingtips of the conventional model. Results have been satisfactory, according to company reports.

By the end of 1954 Sncan had delivered 53 of the series of 140 ordered by the French government for military use. Delivery of the remainder is expected during 1955.

▶**Jet Caravelle**—Further in the future—too far to put positive dates on the prospects—French aircraft producers have three transports in mind. The first prototype of the S.E. 210 Caravelle is due to make its first flight tests in early summer.

This transport is powered by two Rolls-Royce Avon R.A. 16 engines set far back along the fuselage. It is designed to carry up to 70 passengers at a cruising speed of 465 mph.

▶**Turboprop H.D. 70**—Hurel-Dubois' H.D. 70, still under study, will carry on the high-aspect-ratio wing of the current H.D. 32. It will be a turboprop transport, powered by two Rolls-Royce Dart engines.

The plane will carry 36 to 40 passengers, and will carry a payload up to 11,700 lb. on short hauls.

▶**Nord 2600**—Sncan has presented plans for a new medium-range transport for the future. The Nord 2600 will be powered by Rolls Royce Darts together with two Turbomeca Palas jet engines at the wingtips.

It will be designed to carry 40 passengers and an unstated amount of cargo at a cruising speed of about 300 mph. with a range up to 900 miles.

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CONNERSVILLE, IND.	D
CINCINNATI O.	E
WILLIAMSPORT PA.	F
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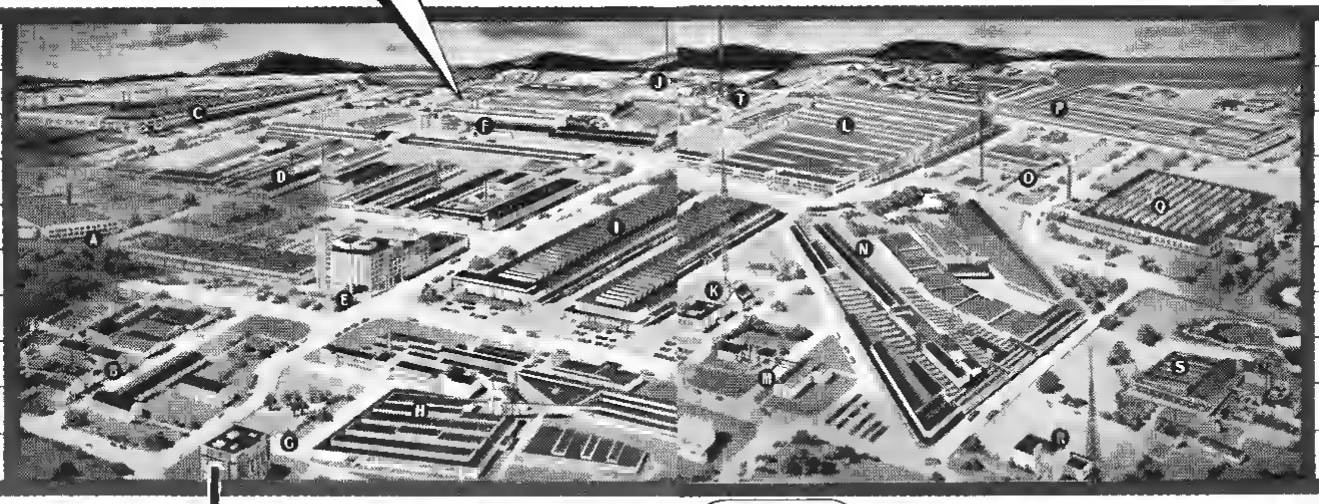
WILLIAMSPORT PA.	H
RICHMOND, IND.	I
ATLANTA, GA.	J



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NEPTUNE AND SUBMARINE

Australians Counting on Air Power

RAAF Expanding With New Equipment

(McGraw Hill World News)

Melbourne—The Royal Australian Air Force is on the eve of becoming Australia's principal arm of defense. It is to be thoroughly re-equipped and modernized with some of the world's most up-to-date aircraft and equipment.

The government has made up its mind to concentrate its efforts on the expansion and modernization of the Air Force. It is reliably understood that money will be made available for this purpose, including dollars, if necessary, for the purchase of modern aircraft and equipment.

Australia realizes that her contribution to the Western preparedness effort can be best expressed in a strong air force and expects her principal allies to assist in the creation of a strong and modern RAAF. The plan is in two stages.

• **Stage 1.** Reequipment of fighter and bomber squadrons with Sabres and Canberras. Slow progress has been reported, but there are justified hopes for some achievement in the not too-far future.

• **Stage 2.** Both local production and purchase in the United States and in the United Kingdom of modern aircraft and equipment. Greater use of newly developed missiles.

▶ **Bomber Squadrons**—Right now the RAAF, under Air Marshal J. F. J. McCauley, is busy reequipping its fighter and bomber squadrons. AVIATION WEEK understands that Canberra jet bombers from the Government Aircraft Factories, Melbourne, are flowing into the 82nd Bomber Wing currently stationed at Amberley, near Brisbane. The 2nd Squadron is now fully reequipped with Canberras and it is confidently hoped that the 6th Squadron will be fully equipped before the end of 1955. The 1st Squadron (at present stationed in Malaya) will be the last unit of the Bomber Wing to be reequipped with Canberras.

The Wing was previously operating locally built four-engine Lincolns, some squadrons are still using the old bombers. As they are reequipped, their old Lincolns are sent to Government Aircraft Factories for refitting. Their fuselage is lengthened by about six feet ahead of wing to take extra crew and modern electronic equipment for sea rescue and anti-submarine operations with the 10th Maritime Squadron, at present stationed in Townsville, Queensland.

RAAF experts are against reequipment of the 1st Squadron while the latter is engaged in anti-Communist operations in Malaya. Lincolns have been found very satisfactory for the Malayan theatre of operations but the government is now studying the question of increasing its participation in Malaya. It is understood that 48 Canberra medium bombers are being built for the Bomber Wing.

▶ **Fighter Squadrons**—Two Australian fighter Squadrons (the 75th and 76th) are about to return from service in Malta. The 77th Squadron, which returned from Korea in December 1954, fought throughout the Korean campaign and its heroism gained for its personnel the highest commendations of Allied commanders.

These fighter squadrons will form the 78th Wing, which will be based at Williamstown, New South Wales.

RAAF has on order about 90 Avon-Sabres, locally manufactured by the Commonwealth Aircraft Corp., Melbourne. Production has been delayed by numerous causes and is only now gaining momentum. RAAF emphatically believes the Avon Sabre is superior (from RAAF's viewpoint) to the Hawker Hunter and F-86E.

At present Avon-Sabres are sent to a special flight at Williamstown. Extensive service tests are not expected to end before July 1955. After the tests, Avon-Sabres will go to the 18th Wing, a squadron at a time.

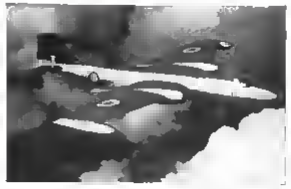
The remainder of the wing will use Gloster Meteors brought from Korea. These Meteors will gradually replace obsolescent Australian-built de Havilland Vampires in the five Citizen Air Force squadrons (these are Australian counterparts of Air National Guard). The CAF squadrons are stationed at Melbourne, Sydney, Adelaide, Perth and Brisbane. It is not expected that this stage of reequipment will be concluded before well into 1957.

Several Australian Dakotas are serving as transports for the British Commonwealth Division in the Korea-Japan theatre.

It is reliably understood that Australia is prepared to accept further commitments in Malaya and that two of its three fighter squadrons will be sent there. These squadrons will then be equipped with Avon Sabres of Australian manufacture.

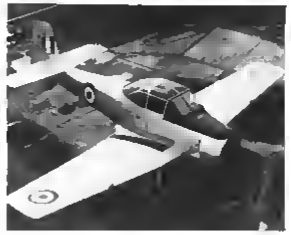
▶ **Buying Plans**—Right now, the greatest interest is centering in future purchases of aircraft for RAAF.

A special mission led by Air Vice Marshall A. M. Murdoch is touring overseas countries to investigate replacements for Avon Sabres, new jet bombers, new transports and a new jet trainer of an advanced design. Details of the mission's recommendations are kept a close secret, to avoid pressure from British manufacturers who are fighting hard to see that the orders go to British factories rather than the



GAF-BUILT CANBERRA

CAC-BUILT AVON-SABRE



CA22 WINJEEL

U.S. or elsewhere.

An RAAF source says the replacement for the Avon-Sabre must be capable of at least Mach 1.5 and preferably Mach 2.0. Australia's need for the aircraft is not immediate and it will select only the best. Under consideration are English Electric P.1, North American F-100 and Lockheed F-104.

It is said that as USAF and RAAF have similar fighter requirements, the plane should be of U. S. design. But it is highly probable that the successful experiment of matching the Sabre with an Avon engine will be repeated and the selected U. S. plane will have a British-designed engine manufactured in Australia under license.

It is believed certain that the entire plane will be manufactured by the Commonwealth Aircraft Corp. This firm has specialized in manufacturing under license from North American Aviation.

▶**Bomber Candidates**—Jet bomber requirements are causing quite a worry. The Boeing B-47 and the British V-type bombers are under consideration.

If SEATO countries insist on Australia sending a bomber force to Singapore, B-47s will have to be purchased. In that case, Australia will attempt to get B-47Es. However if the emergency is not acute, the purchase of bombers will be delayed until 1957 or 1958, and either Vulcans or Victors will be purchased in the United Kingdom. Advantage of such a plan would be the availability of operational experience from RAF.

In any case orders will not be large, probably a few dozen or so, as some Aussie experts believe that, from the economic point of view, Australia should abstain from creating an expensive bomber force. In addition, RAAF's personnel strength in 1957 will not be much above the 17,000 figure.

▶**Transport Situation**—Most urgent immediate requirement is for big, fast, rear-loading military transport aircraft. RAAF experts are quite enthusiastic about the Lockheed C-130 and would love to be able to buy half a dozen without delay.

The Blackburn and General Beverley is not favored by Australia. It is claimed that it is slow and range is too limited. On the other hand, the C-130s fit RAAF's specifications for a military transport. If purchased, they will form a special longrange transport squadron within the 86th Wing.

This wing, stationed in Canberra, is at present operating Dakotas, which are long overdue for replacement. Economic factors prevent the replacement of Dakotas although the U. K. industry would like to offer a number of aircraft, such as the Handley Page Herald.

Helicopters—it is officially understood—will come only after Dakotas are replaced.

▶**Jet Trainers**—Australian authorities have not yet decided whether to buy or to produce a jet trainer locally. They would like something like the French Fouga Magister and have obtained at least three local designs on similar lines.

In the meantime, production will concentrate on the locally designed CA-22 Winjeel powered by the Wasp Junior, to replace obsolete Harvards and Tiger Moths.

▶**Neptunes in Favor**—Australians are so happy with the Lockheed Neptune for maritime reconnaissance that no replacement is discussed or expected before 1960 at the earliest.

The Neptunes are supplemented by the long-nose version of Lincolns.

Australia is about to get another aircraft carrier from England, but naval aviation is not promoted now in the same way as land-based aviation. However the orders earlier placed in England for new naval aircraft have not been canceled.

RAAF's annual budget is about £120 million, but it is certain that money for the longrange military transport and probably the medium bombers will come from other sources. During his current tour, Prime Minister Menzies will endeavor to obtain these planes as part of U. S. contribution to SEATO at no cost to Australia.

Future military aviation plans provide for 16 squadrons including five of the Citizen Air Force. This will include two maritime rescue squadrons, a target towing squadron, a fighter wing of three squadrons, a bomber wing of three squadrons, and a transport wing of two squadrons.

▶**Short of Manpower**—The big problem is to find enough men to fly the aircraft and to provide for ground personnel.

The present net loss to the RAAF is over 700 men a year.

RAAF is by no means optimistic about its chances to attain its 17,000-strong force on schedule.

The increase in RAAF's radar system and its major air field projects will also claim substantial numbers of able bodied men.

The aircraft production industry is still fighting for manpower in a country where full employment and shortage of manpower make such a fight a hard one.

Delays have been numerous and there is a definite need for greater efficiency and lower costs. However, Australia's new emphasis on a strong air force is expected to assist the industry, and the high quality of both flying and ground personnel is expected to gain the support of Australia's allies, particularly the United States.

● AUSTRALIA

Aussie Transport Set for Big '55

(McGraw-Hill World News)

Melbourne—Australia is actively planning further expansion of its services to cope with increased requirements caused by large scale migration and industrialization of the Continent.

The beginning of 1955 saw the major airlines busy re-equipping their fleets and preparing for an era of increased competition. Records in the passenger and freight fields were scored in the last Australian fiscal year, but it is now certain that these records will be again beaten in the current year.

Australian airlines are particularly sensitive to fluctuations in the country's economic conditions and right now Australia enjoys a very prosperous year, although some clouds on the horizon may affect airline results in the second half of 1955.

▶ **Two Contestants**—The truce between the two major airlines, the government-owned Trans-Australia Airlines and privately owned Australian National Airways was precariously maintained. Labor threats to do away with ANA seemed to weaken considerably as Labor was less likely to regain power and had serious domestic troubles to solve.

Australian National Airways continued to reign in the air cargo field. The company was successfully operating its two second-hand DC-6s on interstate routes and was looking impatiently to the early receipt of its two DC-6Bs ordered directly from the manufacturer. These were due for delivery early in 1955 and will be put on routes linking the Eastern States in direct competition with TAA's Vickers Viscounts.

ANA is not thinking of any replacements before 1960 at the earliest. It would like to find something good to replace its obsolescent Bristol freighters, but several British attempts to sell planes to ANA for this purpose (notably Blackburn) have so far failed to persuade. For its passenger fleet requirements ANA may decide to turn to Bristol Britannia, provided the plane proves its value before 1960.

▶ **Viscounts in Service**—TAA had an early upset when its first heavily publicized Vickers Viscount crashed near Melbourne on a training flight.

Subsequent deliveries of Viscounts were given the least possible publicity and the new airliners have been put into operation without further ballyhoo. TAA is not yet in position to give an opinion on the value of the plane although unofficially it has high hopes for the plane's success. When the airline's order is completed TAA will have six Viscounts in operation. It will not surprise anybody here if an order for three more is placed, but they will be of a more advanced design.

▶ **Aircoach Operations**—Ansett Airways is expecting early delivery of its second Convair 340. The first one has proved popular in Australia, and with the addition of the second, Ansett will be in position to harass the major airlines to a much greater extent.

The competition is reliably understood to be preparing for a counter-attack against Ansett, Australia's only major aircoach fare operator. TAA and ANA will probably refit some of their DC-4s for aircoach operations and will put them on the popular routes in direct competition with Ansett. Fares will be reduced by up to 15% and the Skymasters will carry a very large number of passengers on these flights.

If and when conversion kits for Convair 340s become available at economic prices Ansett may buy them for conversion to turboprops.

Few purchases are envisaged by small operators. Main factor limiting their purchases is state of the airports and strips in regions of their operation.

▶ **Qantas Set Till '60**—In the international aviation field, main attention is given to Qantas Empire Airways. Qantas' fleet of 10 Super Connies is expected to be the mainstay of the airline until at least 1960.

An advanced model of Bristol Britannia may be purchased in 1960 or, perhaps, a greatly improved Comet, but it is most unlikely that the Comet 2, originally ordered by the now defunct BCPA will be purchased by Qantas.

There is always the possibility, however, that competition over the Pacific may force Qantas to buy a U.S.-made plane for this route.

▶ **Year of Expansion**—In spite of all these factors it seems certain that 1955 will see another year of expansion in Australian air operations.

With bigger and better planes the road is open to further gains in a country where long distances and rapidly increasing population are calling for great development of air traffic.

The exceptional safety of Australian air operations is making for more popularity of air travel, as is the advent of aircoach fares.—**Alicja Grobtuch**

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P 5758—Aviation Week
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RW-5821, Aviation Week
330 W. 42 St. New York 36, N. Y.

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RW-5000 Aviation Week
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(Additional Undisplayed Ads on page 360)

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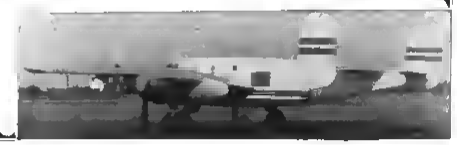


ADVERTISERS IN THIS ISSUE

AVIATION WEEK—MARCH 14, 1955

NEWS DIGEST

Domestic

Corporal Mk. 2 guided missile for surface-to-surface use is being adopted by the British Army, which will organize units next year to use the weapons, Antony H. Head, Britain's war secretary, has disclosed. He also said a mission will come to U. S. in a few months to become acquainted with the Corporal, which he said is "ahead of any other ground-to-ground guided missile in the world."

Sigmund Janas, Sr., former president of Colonial Airlines, has pleaded guilty of 20 of the 40 charges lodged against him alleging falsification of the airline's records. Janas faces a maximum fine of $200,000. Colonial pleaded guilty to flying passengers at illegally low rates in three instances and is subject to a maximum fine of $15,000. Janas reversed his former plea of not guilty. The case is the first criminal prosecution to come up under the Civil Aeronautics Act of 1938.

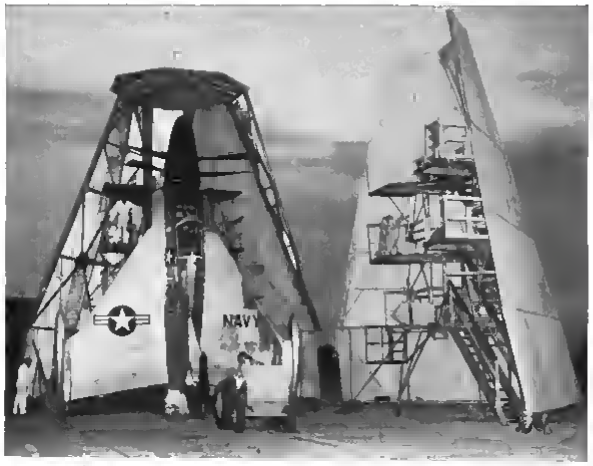
North American Airlines has ordered three more 102-seat DC-6Bs from Douglas Aircraft Co. Order brings the nonsked's total investment in DC-6B equipment to $6.5 million. The airline took delivery on its first in December, second last month. North American plans eventually to convert its entire fleet to DC-6Bs.

U. S. Navy has ordered four de Havilland Otters from Canadian Commercial Corp. under a $564,800 contract. Navy designation of Otter is UC-1. Single engine transport will be used to support the U. S. expedition to the Antarctic next fall.

Martin B-57 light jet bombers will be ungrounded by USAF following inspection and cleaning of certain electrical components. B-57 was grounded last month following two crashes (AVIATION WEEK Feb. 21, p. 7).

United Air Lines has been studying the Vickers Viscount with possibility of purchasing the turboprop transport, Walter H. Neff, special assistant to the UAL president, said at Toronto after a flight in a Trans-Canada Air Lines Viscount.

North American Aviation Inc. has been awarded a half-million dollar contract to build the first nuclear reactor designed specifically for industrial research. Contract was awarded by Armour Research Foundation of Illinois Institute of Technology, Chicago. Reactor will be located in a new research building to be constructed on Chicago's south side. Reactor is designed as a source of neutrons and gamma radiation rather than for production of power. It is of the "water boiler" type, fuel is a water solution of uranyl sulphate to be obtained from Atomic Energy Commission on extended loan.



Convoir "Pogo" Enters Tepee Hongor

Tractor maneuvers the Convair XFY-1 "Pogo" vertical takeoff fighter into its novel, tepee-shaped hangar at Brown Field Naval Auxiliary Air Station near San Diego, Calif. After the fighter is positioned, the section at right will be wheeled into place, providing full enclosure. Note hangar's triple-deck work platforms which allow access to all parts of the XFY-1. The unusual snug-fitting shelter was built by Convair personnel in only three weeks. Easily dismantled, it is 36-ft. high and is a wood and steel framework covered with yellow fire-resistant fibrous glass plastic.

United Air Lines has voted for elimination of the reconfirmation rule for airline passengers as quickly as possible in ballot being taken by Air Transport Assn. Purpose of the rule was to help reduce no-shows.

North American Aviation, Inc. has awarded a $3-million contract to George A. Fuller Co. for construction of a propulsion development center at Canoga Park, Calif. Building will be used for research, engineering, development and manufacture of rocket engines for USAF. Completion is scheduled for October.

Ryan Aeronautical Co. received $4 million in new business this month. $2.5 million from General Electric for jet engine components and afterburners, remainder from Jet Engine Division of Ford Motor Co., Pratt & Whitney Aircraft, and Wright Aeronautical Division. New orders project deliveries into 1956.

President Eisenhower's recommendation of a two-year extension of the Renegotiation Act, expired Dec. 31, seems to assure its continuation (AVIATION WEEK Mar. 7, p. 12).

Senate Small Business Subcommittee on Relations of Business with Government has selected civil aviation as an area on which it plans to concentrate in this session. The subcommittee has been consistently critical of Civil Aeronautics Board and has urged a more lenient attitude toward nonskeds. Subcommittee on Military Procurement plane will study share of contracts going to small businesses, Defense Department's directive on maintenance of the mobilization base (AVIATION WEEK Dec. 20, 1954, p. 12), programs for increasing subcontracting for smaller firms and expansion of primes into fields handled by small business.

National Airlines is continuing its fight to block a merger of Eastern Air Lines and Colonial Airlines by objecting the findings of a Civil Aeronautics Board examiner in the EAL-Colonial case (AVIATION WEEK Mar. 7, p. 70). In a document filed with the CAB, National takes exception to a long list of conclusions in the initial report. A major contention of NAL basic issue in determining whether Eastern controls Colonial is the question of whether Eastern has the power to control individuals whose potential influence is at issue.

Congressional reviews of Air Navigation Development Board's decision to proceed with the development of Tacan as a common air navigation system were launched with testimony by Trevor Gardner, Assistant Secretary of the Air Force for Research and Development and a member of ANDB, supporting the action before a subcommittee of House Government Operations Committee. House Interstate and Foreign Commerce Committee also has programmed "a complete investigation" as a result of protests over the plan to supplant the DME/VOR with Tacan. Senate Interstate and Foreign Commerce Committee also has announced plans to conduct hearings on the controversy.

Albert W. Bentz has left AVIATION WEEK. An announcement of his new position is expected shortly.

Navy's Fiscal 1956 shipbuilding and conversion program, designed around long-range needs, includes six frigates designed for antisubmarine and anti-aircraft warfare in addition to a fifth carrier of the Forrestal class. Three of the frigates would be armed with guided missiles for defense against air attack. Details of the program were disclosed to the House Armed Services Committee by Adm. Donald B. Duncan, Acting Chief of Naval Operations. In addition to new ships, the Navy plans conversion of others to provide angled decks on six carriers. One light cruiser will be converted to carry the Talos missile and a destroyer will be fitted to carry the Terrier missile. Both are surface-to-air weapons. Adm. Robert Carney's message to the committee stated the program is designed to "project air power where it will be most effective" by providing adequate fast carrier forces.

Nonskeds role will be thoroughly reviewed by House Interstate and Foreign Commerce Committee this session. Chairman Percy Priest says. Introducing an omnibus aviation bill providing for regulation of contract carriers as well as nonskeds, he expressed concern at charges "by some of the nonscheduled lines that a monopoly exists in air transportation" and at "countercharges that the 1938 CAA Act is being subjected to wholesale violations."

New orders totaling $26.8 million have been received by Rohr Aircraft Corp., Chula Vista, Calif., for power packages for the Douglas DC-7C, Lockheed C-130 and Boeing B-52. Aft fuselage sections for the B-52 are also included. Rohr backlog now $145 million.

Civil Aeronautics Board has held up approval of acquisition of California Central Airlines by Allegheny Airlines and Southwest Airways pending arguments on legal points of control involved. SWA and Allegheny made a deal for defunct Cal-Central's Martin 2-0-2s and DC-3 equipment and entered a bid for quick CAB approval. A group of Cal-Central employes objected, however, and the Board decided to hear arguments.

Domestic and international scheduled airlines flew 21,277,438,000 passenger-miles during the past 12 months with a fatality rate of 0.16 per 100 million passenger-miles. International, local service and territorial carriers completed the period without a fatal accident. Domestic trunklines had four fatal accidents during the year.

Aviation Crash Injury Research Project of Cornell University will move from its present quarters in downtown New York City to more spacious offices in the Marine Terminal, LaGuardia Airport, L. I., N. Y. on Mar. 15. In line with AvCIR's increased activity, A. Howard Hasbrook has been moved up to director and Jerome Lederer is now coordinator of all Cornell aviation safety activities in the New York area.

Financial

Boeing Airplane Co., Seattle, Wash., reports total sales of $1,033,176,265 for the period ended Dec. 31, 1954, the first time in the firm's history in which sales topped one billion dollars. Figure exceeds preceding year by $114,930,319. Net earnings after taxes last year were $36,976,023 compared with $20,318,178 for 1953. Boeing's net worth now totals $109,441,257, an increase of $27,246,901 over 1953. Backlog of unfilled orders as of Dec. 31 $2,131 million.

United Air Lines operating revenues totaled $200,719,242 in 1954, a 16% increase over last year. Net earnings were $9,617,694, an increase of 6%. Total expenses rose 16% to $178,832,489. Earnings per common share were $3.52, compared with $3.29 in 1953. Passenger traffic increased 22% to 3,326,736,000 revenue passenger-miles. Total ton-miles 388,173,000, a 21% increase.

Northrop Aircraft, Inc., reports net income of $6.6 million for the six months ended Jan. 31, compared with

Navy Shows How it Can Fuel Seaplanes at Sea From Sub-Tankers

A Martin P5M-1 Marlin flying boat is refueled in the open sea from a moving submarine tanker during recent exercises in the Caribbean. Submarine-seaplane refueling is an important new element of the Navy's concept of mobile striking power. In event of hostilities, sub-supported seaplanes would provide an elusive force capable of striking at an enemy from many directions.

British Intensify Olympus Jet Flight Tests

An Avro Ashton takes off on a flight test carrying two Bristol Olympus turbojets in pods, one under each wing outboard of the plane's normal complement of four Rolls-Royce Nene jets in twin nacelles. The Ashton's extensive instrumentation will record the performance of the pod-mounted Olympus jets at high altitudes.

$1.12 million for the same period a year ago. This amounted to $4.44 a share after a two-for-one stock split, compared with 87 cents, adjusting for the stock split, for the period last year. Consolidated sales for the period $145.5 million, compared with $77.95 million a year ago.

International

Great Britain has announced through its Atomic Energy Authority and Ministry of Supply that it is working on development of a nuclear aircraft engine. One of the companies in the program is Rolls-Royce, which is studying reactor technology at Harwell.

British Overseas Airways Corp. will show a profit for the fiscal year ending Mar. 31, despite grounding of its Comets last April, Chairman Sir Miles Thomas says. Profit will not be as much as last year's $2,983,111. Skeptical of early delivery of turboprop powered Britannias, Sir Miles said two major decisions have given his company a firmer basis for planning: for return of Comets, and permission to buy 10 Douglas DC-7Cs.

Trans-Canada Air Lines pilot has been blamed by a Canadian board of inquiry in the crash of a Super Constellation last Dec. 17 while making a landing at Toronto. Pilot was accused of poor airmanship, lack of alertness and breaking altitude regulations. Plane crashed 11 miles west of Toronto on a flight from Tampa, Fla., but no one was killed. Canadian Airline Pilots Assn., countered board finding by saying fatigue from overwork, not negligence and poor airmanship, caused crash.

DC-3 gross weight cut to 25,000 lb. has been ordered by Australian Dept. of Civil Aviation following refusal by pilots of Australian National Airways and Guinea Airways to fly the planes at 26,200 lb. carrying passengers and 26,900 lb. as freighters. Decision covers only Wright Cyclone-powered versions, reportedly will be rescinded when modifications are made.

Canadian Marconi Co., Montreal, has been awarded a contract to set up a chain of radio stations to handle communications during construction of DEW (distant early warning) radar network in Northern Canada by the U. S. government.

Compania Mexicana de Aviacion DC-3 crashed into a mountain near Mascota, Mexico, Mar. 8. All of the 25 persons were believed killed.

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